PART V: INTRASITE SPATIAL ANALYSIS

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Introductory Remarks on Intrasite Spatial Analysis

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Analysis of the spatial arrangement of artifacts within an archaeological site has two primary tasks. The first, which requires R-mode operations, aims at defining the degree of similar or dissimilar spatial arrangements of different artifact types or attributes over the site. Such patterning, with appropriate bridging arguments, can be used as evidence of the past operation of various activities, other cultural formation process, or natural formation processes. The second task, which requires Q-mode operations, aims at defining the spatial positions and limits of clusters, voids, or other interesting arrangements of artifacts that are of various types or that have certain attributes. This is done to document the different spatial distributions of different activities or other formation processes over the site, and the various relevant characteristics of their distributions. The results of both kinds of analyses can then be used to estimate the values taken by variables that comprise the behavioral-environmental system under study, of which the activities and formation processes are a part. Local population density, degree of mobility, and pattern of mobility are examples of such variables.

NEW TECHNIQUES

The two chapters by Carr, and Gladfelter and Tiedemann, respectively, introduce new techniques for achieving the R-mode and Q-mode operations previously described. Carr introduces four *similarity coefficients* (AVDISTGM, AVDISTLP1, AVDISTGP, AVDISTLP2) that can be used to define the degree of coarrangement of artifacts over an area. The different coefficients are appropriate under different conditions, depending on the form of organization of any depositional sets of similarly arranged types that may occur in the study area (i.e., relevant relational data structure), as determined by the processes of formation of the sets. The particular archaeological organizations and formation processes that are congruent with each coefficient are specified. All the coefficients require data in the form of item point locations.

Carr also introduces a new *clustering algorithm* (OVERCLUS), which is capable of grouping artifact types into multitype sets on the basis of the new similarity coefficients or other standard coefficients. Importantly, the algorithm allows, but does not require, the formed sets of types to overlap in membership. It thus accommodates typical variation in the relevant organization of depositional sets. The method is technically preferable to other algorithms that are currently available for defining overlapping sets in that it 1) does not require the specification of vital parameters of a data's relevant structure prior to analysis (e.g., number of types overlapping between groups), 2) allows control of the degree of inconsistency between pairwise relationships that is smoothed out of the data in arriving at a solution, 3) is efficient, and 4) is concordant with a wide diversity of similarity coefficients.

Finally, Carr evaluates other multivariate techniques that can be used to group types into depositional sets, including factor analysis, standard clustering procedures, and multidimensional scaling. These are evaluated for their degree of concordance with the potentially overlapping form of organization of depositional sets and the degree to which they are technically advantaged in the ways just mentioned. All of these considerations suggest the use of OVERCLUS, in conjunction with multidimensional scaling, as an optimal approach for defining multitype sets of artifacts.

The chapter by Gladfelter and Tiedemann introduces a new geographic technique—the continguity-anomaly (CA) method. This method, when used to analyze intrasite artifact distributions, is capable of determining the positions and spatial limits of clusters or voids of artifacts that are of a single type or that have certain attribute states. The method, which requires data in the form of grid cell counts of artifacts or other cell values, achieves this task through a systematic examination of the differences in cell counts or values among contiguous cells. This operation allows the identification of particular cells that are of a given level of similarity to or dissimilarity from surrounding cells. Such cells represent either whole clusters/voids, cells within gradations of change at the boundaries of such areas, or cells within such areas, depending on the mesh of the grid and the nature of the contiguity relations. Examination of cell value differences also allows the testing of such interesting cells for the statistical significance of their differences from neighboring cells and, thus, the significance of local autocorrelation or lack thereof.

Gladfelter and Tiedemann's general perspectives on spatial analysis, which led them to develop their contiguity-anomaly method, are similar to those that led Whallon (1984) to develop his productive methodology, *unconstrained clustering*. Both sets of researchers emphasize the importance of evaluating *local variation* in a spatial arrangement as opposed to its global, overall form of arrangement. In achieving this end, both sets of researchers have developed methods that *classify* cells/locales in accordance with their degrees of similarity to or dissimilarity from other cells/locales.

The two methods are equally advantageous compared to many other techniques in that they 1) do not assume any degree of spatial autocorrelation of cell values among cells; 2) are not plagued by a boundary problem; 3) do not assume that the global population of cell values conform to any well-known frequency distribution; 4) can accommodate data in either a grid cell format or an item point location format that has been transformed to a grid cell/local neighborhood format; and 5) allow the use of any of a broad range of variables in characterizing a cell, such as local densities or proportions of artifact types, or statistical moments of certain properties of the artifacts within cells/neighborhoods.

The two methods are complementary in two ways. The CA method allows assessment of the statistical significance of the departure or lack of departure of a cell's value from those of other cells, whereas unconstrained clustering does not. Unconstrained clustering allows multiple variables to be considered simultaneously in the evaluation of cell similarities and differences, whereas the CA method is essentially univariate in nature (although ratios of two variables and other multivariate summary measures can be accommodated).

Both methods are disadvantaged in that they employ a *single global* threshold, rather than locally variable thresholds, for defining significantly similar or different cells. This can imply erroneous assumptions about the nature of artifact organization and site formation. The single global threshold can imply, for example, an equivalent degree of internal homogeneity of all clusters in their artifact densities or compositions, and an equivalent degree of density or compositional contrast of all clusters from their backgrounds. A more detailed review of the advantages and disadvantages of both techniques, in relation to the nature of organization of intrasite archaeological records, is given by Carr (1984).

ENTRY MODELS AND POLYTHETIC ORGANIZATION OF DEPOSITIONAL SETS

Carr's chapter discusses a number of issues pertinent to the general volume themes, which need to be emphasized.

1) The use of *entry models* and *parallel data sets*, as one strategy for determining the relevant structure of a complex data set and for specifying the technique(s) appropriate for analyzing it (Carr, chapter 2), is exemplified. Data sets that are comprised of information on the spatial arrangements of various artifact types across a site are envisioned as complex data sets. Sets of information on the manner of formation of those arrangements are taken to represent parallel data sets that can give insight into the nature of relevant organization of the complex artifact arrangements.

2) Twelve models of possible organization of depositional sets in the archae-

ological domain are defined. These represent different *relevant relational data structures* that are generated under different conditions of formation, disturbance, excavation, and encoding of an intrasite archaeological record. These models, along with the processes that are responsible for them and the techniques of analysis that are concordant with them, represent entry models. The models can also be used to describe the organization of artifacts among and within activities in the behavioral domain, in ethnoarchaeological work.

3) The constructs of *polythetic and monothetic* organization, which are useful in modeling different kiinds of relevant structural relationships among archaeological entities in general (Clarke, 1968; Williams et al., chapter 11), are linked to more basic, determinant dimensions of structural variation. These include local variation in the magnitude, direction, and completeness of *asymmetry relations* among entities. More detailed remarks on Carr's and Williams et al.'s discussions of monothetic and polythetic organization in this volume are given in chapter 6 (pp. 125-126).

4) Carr's chapter stresses and illustrates that the appropriateness of a technique for analyzing data cannot be judged in a *general*, a priori fashion, on the basis of the *number* of constraining assumptions that it makes about the nature of relevant data structure—a criterion for acceptance of analytic results that is in line with an exploratory data analysis approach to data examination (Carr, chapter 2). Rather, the *particular nature* of the assumptions and their degrees of congruence with the relevant form of organization of the *particular data* in hand is what matters.

Other points in Carr's paper that should be noted concern intrasite spatial analysis in general. These are the following:

5) It is proposed that the *inferential goals* of intrasite spatial analysis be widened to include not only the reconstruction of past activities, their frequencies, and spatial arrangements, but also various extra-activity cultural formation processes (e.g., curation rates, regional mobility patterns) and natural formation processes. All of these phenomena are useful as indicators or estimates of the states taken by variables that comprise past behavioral and environmental systems.

6) In regard to the *operational goals* of intrasite spatial analysis, it is argued that the search for supralocal (perhaps site-wide) relationships among artifact types, indicating supralocal depositional sets, can remain a valid goal. This is true so long as (a) the technique of analysis that is used is insensitive to any irrelevant local variation that may occur over space in the magnitude, direction, and/or completeness of asymmetry among coarranged types, and (b) the area that is examined does not include relevant localized relationships among artifact types that are contradictory (i.e., there is no pooling of relevant structures and populations). An opposing viewpoint on operational goals is taken by Whallon (1984).

FUTURE RESEARCH

The studies by Carr, and Gladfelter and Tiedemann, suggest some future lines of research that would be useful. These include 1) the specification of additional dimensions of variation of depositional set organization beyond those concerned with asymmetry and overlap, and the linkage of formation processes and concordant techniques to organizational variation along those dimensions, in the effort to develop more sophisticated entry models for getting into spatial data sets; 2) investigation of the optimal complementary uses of OVERCLUS and multidimensional scaling procedures in smoothing and representing spatial data; 3) extension of the CA method so as to make possible the statistical assessment of the form of arrangement of supralocal artifact distributions and their coarrangement; and 4) extension of the CA method so as to make possible the statistical assessment of local autocorrelation at varying geographic scales. The latter can currently be achieved cumbersomely by varying the mesh of the grid that is used. It also might be accomplished, however, by varying the number of k neighbor cells to which central cells are compared and the distance of neighbor cells from central cells, in a manner analogous to spatial filtering approaches (e.g., Scollar, 1969).

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