# CHAPTER 4: NON-CLASSIFICATORY ARRANGEMENT

In preceding chapters that kind of arrangement called classification has been treated in some detail, for classification is the systematic foundation of science. As a result, this concluding chapter of the general consideration focusing on non-classificatory arrangement may seem out of place. The reasons for including a superficial consideration of non-classificatory arrangement are two: (1) the substantial confusion that exists between at least some forms of non-classificatory arrangement and classification, both paradigmatic and taxonomic, a confusion accompanied by an attempt to replace classification with one or another form of non-classificatory arrangement without a critical consideration of the consequences of so doing; and (2) as a corollary to this, the tendency to accept or reject classification or non-classificatory arrangement to the exclusion of the other and with little attempt to delineate the relationship between the two. It should be clear from the outset that non-classificatory arrangement, both in principle and as a technique, is not rejected here except as a substitute for classification in scientific inquiry. By the same token, classification must be rejected as a substitute for non-classificatory arrangement used in its proper role. The main aim of this consideration is to delimit the domain of both kinds of arrangement and to programmatically indicate the relations obtaining between the two in pragmatic terms.

Though in both archaeological and non-archaeological literature the kinds of arrangements grouped together here as non-classificatory arrangement are often labeled “classification,” especially when there is an attempt to replace a classificatory scheme, all the forms treated here hold in common: (1) the absence of intensionally defined classes as a product; and (2) a concern with the phenomenological world in an at least overtly, theory-free context, resulting in the formulation of groups as end products. This fundamental difference between classification and non-classificatory arrangement as illustrated in Figure 3 where the latter is indicated under the heading of identification and grouping devices.

Since the differences between classification and the operations considered here are substantial, it is necessary to introduce two notions, those of group and those of similarity. The notion of group was touched upon in the introduction; however, expansion is crucial for a specific consideration of non-classificatory arrangement. Group, for the discussion herein, is to be understood as an aggregate of actual events o; objects, either physically or conceptually associated. Groups are phenomenological-they have objective existence in their constituent entities, although the “groupness,” the association of the entities, is always in some measure non-objective. By virtue of objective existence, they are historical and contingency-bound. A group and each or any of its constituent entities exists at a given point in time in a given place. Groups have locations, not distributions, and so cannot be shared or held in common. As a result, the constraining boundaries of groups are not formal characteristics of the constituent entities, but rather are always ultimately reducible to temporal/spatial limits. Historical contingency is always incorporated in groups. When “definition” is used with reference to groups, one of two things is usually meant: (1) a statement of the temporal/spatial limits; or (2) an enumeration of the objects or events comprising the group or a statistical summary of same, that is, an extensional definition. An object or event cannot be assigned to a pre-existing group on the basis of its formal characters without altering the “definition” of the group. Being part of the phenomenological world, the construction of groups limits the data which can be considered to that finite set of cases incorporated in the original formulation. Groups always have a finite number of members in finite time and space.

These enumerated characteristics of groups are readily recognizable as characteristics of objects/events in the common sense of the words, and all follow from the phenomenological nature of groups. Groups inhere in phenomena as aggregates of actual cases. The contrasts between groups and classes are obvious:

1. Classes are intensionally defined on the basis of formal features of objects; groups are “defined” by enumerating and/or summarizing the members or by stating the temporal/spatial limits of the group.
2. Classes are ideational units which exist independent of time and space and whose *denotata* can occur simultaneously at more than a single location or can occur at more than a single point in time at the same place, whereas groups are phenomenological and thus are governed by the physical laws concerning time/space/matter.
3. As a corollary, classes have distributions; groups have locations.
4. Classes are infinite in terms of their application, and any object or event acquired after the formulation of a classification can be assigned to a class without altering the definition; groups, on the other hand, are restricted to that set of objects/events originally incorporated in the group, and the addition of new information necessarily alters the “definition” of the entire group.

The consequences of these contrasts for pragmatic operations are a major portion of the basis for assessing the roles that classification and non-classificatory arrangement can legitimately play in scientific investigation.

In spite of these fundamental and seemingly apparent contrasts, certain kinds of confusion obtain in practice in differentiating classes and groups as a consequence of their analogous nature. The practical basis for this confusion lies in our own “common sense” environment. The assembled *denotata* of any class constitute a group in the sense used here. The problems in differentiating classes and groups stem from a confusion of the *denotata* of a class with the class itself. Where there is but a single classificatory scheme conceived possible, such as within a single cultural system or as within such sciences as are preoccupied with a single line of inquiry into a given subject matter, the pragmatic differences between attributes and features, between groups and classes, are negligible. In such conceptually-bounded circumstances the *denotata* of a class and the class itself are for practical purposes synonymous. Insofar as there are no alternative conceptions of a given set of phenomena, matters of definition, distribution, and application are trivial. Evaluation of the classes or groups is, however, impossible. When alternative classifications for the same set of phenomena are conceived possible or when evaluation of a set of categories is necessary, then the distinction between classes and groups, between the objects assigned to a class and the class itself, assumes paramount importance.

This consideration brings us to a most important point, the relationship of classes to groups, not in a formal sense such as outlined above, but in pragmatic terms. Classes are one means of associating the various constituents of a group. Assembling the extant *denotata* of a class, or a portion of the extant *denotata*. is one important means of creating groups. The necessary and sufficient conditions for class membership provide the means for creating the aggregate. However, the *denotata* of a class as a group consist of all the distinguished attributes of the objects/events included, not just the definitive features. Further, any set of assembled *denotata* is historical and contingency-bound. The actual *denotata* of a class viewed as a group are continually changing with the addition of new information. The assembled *denotata* of a class, while a group in the full sense of the term, are a very special case in which the criteria for creating the group remain contingency-free and thus capable of infinite expansion and incorporation of new information. The process of identification, the comparison of objects with the necessary and sufficient conditions for class membership in order to assign members, is the crucial link between classes and groups as represented by *denotata*.

The identification of objects with classes is not the only means of creating groups. A group can be created through any means of physically or conceptually associating objects or events. Groups can be created by arbitrarily drawing lots or by closing one's eyes and piling together things on one's desk. Most overt procedures for creating groups, however, make use of the notion of similarity, the second important concept in non-classificatory arrangement.

Unlike its counterpart in classification, identity, similarity is not precisely definable in a theoretical sense. In formal or phenetic terms, similarity is rephrased but not defined as “resemblance” of objects or events. In genetic (historical) or cladistics terms, similarity cannot be precisely defined in theoretical terms, for similarity is a relative state based upon the actual case being considered. Here lies an important contrast with the analogous notion of identity. Identity, too, is a relative state, but not relative to contingency-bound phenomena but rather relative to a given problem. Identity is determined in the context of problem, similarity in the context of phenomena. Similarity, then, is a contingency-bound notion which embodies a recognition of our earlier proposition that the phenomenological world is to be profitably conceived as an infinite series of uniquenesses. Identity denies the relevance of this proposition for a given line of investigation, and thus, being entirely within the ideational realm, permits demonstrative reasoning. Similarity, on the other hand, functions in the phenomenological realm permitting plausible reasoning.

Ultimately, similarity can be reduced to identity, identity of features of the objects or events being compared. The only means by which similarity can conceivably be defined or assessed is by the enumeration of features held in common by the compared instances. Such features, because of their recurrence from object to object, are obviously primitive classes. It is most unfortunate that this analytic classification is covert and intuitive in grouping procedures, especially since there is no a priori reason why it must be. If, however, the underlying analytic classification were explicit, grouping procedures would appear not as means of creating units but as means of stating the distribution of classes (features) over a given set of objects.

Be this as it may, two aspects of grouping must be emphasized: (1) Lacking a formal analytic step, groups cannot provide intensionally defined units which are capable of evaluation -the features upon which groups are based are assumed rather than treated as hypotheses with the resulting organization providing a test of the hypotheses as is the case with classification. And (2) because grouping counts and thus requires actual phenomena, the products are groups restricted in their organizing capacity to the data upon which they are based. The precision obtained with grouping devices is superficial, being a precision of mechanical manipulation rather than in meaning or utility.

Those devices which employ similarity as the central concept in group construction are generally polythetic, ie., make use of a “large number” of features, or, more naively, “all features.” The assumption lying behind this approach appears to be that there is but a single scheme for the delineation of features, so that number becomes a measure of “completeness.” The notion of “all features” is, of course, contrary to our basic propositions about the phenomenological world, but, most importantly, it negates the basis for and the utility of the concept similarity, itself a means adapted specifically to deal with uniqueness and infinite (though not unpatterned) variability. For these reasons only the notion of 'large number” requires any further attention. The necessity for “large numbers” of features derives from the relative nature of similarity in relation to phenomena. Given that similarity is a relative state, it must be assessed in degree rather than in absolute terms. Degree of similarity permits the “resemblance” of sets or pairs to be precisely compared and stated, and can be reckoned in many ways, usually in number of shared features or in percentage of shared features. Obviously the fineness of measure is a direct function of the number of features. The larger the number of features, the more discriminations of similarity that can be made, and the finer the measure of similarity, the more precision that can be achieved in creating and comparing groups. These similarity-based grouping devices aim at universally useful categories; however, as noted in Chapter 1, as the number of features considered is increased, the conceptual space covered by any combination of features is proportionately decreased so that the absolute number of categories increases. As the number of features approaches “completeness” the number of categories approaches the perceived number of phenomena, and the advantages of categorization in the first place are lost. Categories are reintroduced into similarity-based grouping by considering degrees of similarity. Groups may be formed by associating sets of things which share a certain number or a certain percentage of the total enumerated features. As shown in Figure 8, while most members of the same group constructed in this manner will share a majority of the same features, it is not necessary that any two things hold in common any features, for sharing can be accomplished through intermediate phenomena. This readily distinguishes classes and their *denotata* from groups. Groups do not necessarily have any constant, specifiable content analogous to the *significatum* of a class. It is for this reason that intensional definitions of similarity-based groups are impossible. The only means of definition is enumeration of the object or event included in the group.

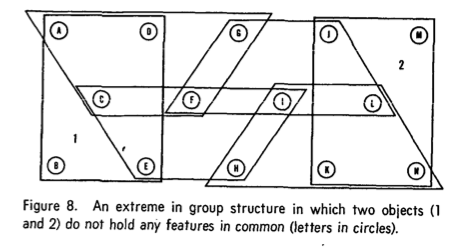


Figure 8. An extreme in group structure in which two objects (1 and 2) do not hold any features in common (letters in circles).

The enumeration of shared features permits only the definition of similarity in a given case. It provides the terms in which similarity may be discussed; however, “definition” of the term necessarily varies from one case to the next. Because similarity by virtue of counts is contingency-bound, it cannot be defined apart from each specific set of phenomena. Similarity when used herein, is thus to be understood as a quantitative assessment of the number of features shared by two or more objects or events. Intuitive and non-quantitative assessments where the basis of everyday similarity, are not usefully treated as similarity here, for their basis lies in a shared cultural background of the users and not in objective, overt statements.

As has been implied, within the category of non-classificatory arrangement it is grouping devices rather than identification devices which are seriously confused with classification, for groups are the phenomenological analogues of classes. Implicit, too, in the discussion of similarity and group concepts is that there are kinds of grouping devices as there are kinds of classification. Figure 9 presents a classification incorporating both classification and grouping, differentiating both in terms of the intimal/external source of limiting parameters used in the discussion of classification. The analogous nature of classification and grouping and of kinds of classification and grouping are obvious. The internal/external contrast has already been explicated for classification. With reference to grouping, this contrast separates those kinds of grouping devices which create units by combination or association of features and which are herein termed statistical clustering, and those grouping devices which divide fields of phenomena by means of degrees of similarity, herein called numerical taxonomy. In the first case, paralleling paradigmatic classification, any set of groups is essentially equivalent and unordered, while in the second case, paralleling taxonomy, the sets of groups are essentially unequal and hierarchically ordered. With the recent increased availability of computer time, experimentation with grouping demanding large numbers of calculations has resulted in a wide variety of techniques of grouping. For this reason, coupled with the fact that grouping as a whole is tangential to our main concern, the consideration of each form is a highly restricted sample, restricted with an eye to providing a background for a consideration of grouping as used in prehistory.

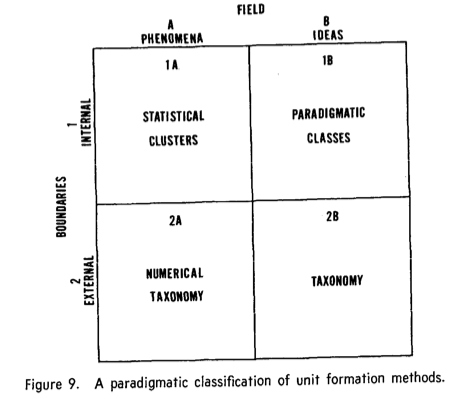


Figure 9. A paradigmatic classification of unit formation methods.

## Statistical Clustering

The heading statistical clustering may be somewhat deceptive since all groups have characteristics that could be called “clusters,” and, further, the term “cluster” or cluster analysis is not infrequently used with reference to some of the methods which would here be included under the rubric “numerical taxonomy.” Statistical clustering is restricted to those methods which examine the association of attributes. A number of methods are available which make use of attributes (features in terms of the distinctions drawn herein), as the basic data input and which further create groups by summarizing the manner in which these features combine with each other in one or another kind of larger unit, usually discrete objects. All involve, overtly or covertly, some kind of “coefficient of association” and make only secondary, if any, use of the notion of similarity as the main device for the actual creation of groups. Techniques of this sort, while not as important in science in general as those termed “numerical taxonomy,” have seen important use or at least proposed use in prehistory. Because of its simplicity which makes for good illustration and because it has figured prominently in prehistory's literature, chi-square clustering or sorting will be treated in some detail.

Like all of the techniques included as statistical clustering methods, chi-square clustering makes use of features as the initial input, features which must be mutually exclusive and dimensionally conceived. Ordinarily the operations involved are phrased as the discovery of consistently associated features, and thus the resultant groups are thought of as coherent bundles or clusters of features. Some methods simply calculate (record) the observed frequency of combination of these features and then examine these data for associations of high frequency relative to combinations and associations of low frequency or non-occurrence, that is, positive and negative coefficients of association. Chi-square clustering does essentially this, but additionally weighs the observed frequencies of combination of features in terms of the size of the sample being considered, taking into account sampling and the effect this has on association. Indeed, since grouping devices deal with phenomena, they all must take into account sampling before their results can be evaluated.

The basic procedures in chi-square clustering, once one has the sets of dimensional features to be used and once one has a bounded, finite sample, are fairly simple. First the frequency of occurrence of the features themselves is tabulated for all members of the sample. From this information can be calculated the expected frequency of combination. The expected frequency is obviously based upon the frequency of occurrence of the features alone and states how many examples of a given combination of features one would expect to find in the sample given its size. Expected frequencies are calculated for all possible combinations of features.

The second part of the procedure involves a tabulation of the actual observed combinations of features in the sample. The observed frequencies of combination or associations can then be compared with the expected number of occurrences. The expected frequencies represent the situation in which there are no tendencies for features to combine preferentially with others and thus represent random association.

The hypothesis made by chi-square clustering is that there are no patterned combinations in the sample. If the differences between each of the actual frequencies of association and the analogous expected frequencies are calculated in terms of units of standard deviation, the limits within which the observed frequencies can be considered a function of the sample can be read from tables and converted into statements of probability. Those frequencies which lie beyond the range of deviation attributable to the sample are then regarded as significant. If no frequencies occur which are significant, then the objects or events considered, in terms of the features used, are regarded as of the same kind. Both negative (frequencies significantly smaller than the expected number) and positive (frequencies significantly larger than the expected number) correlations may occur. In both cases special forces or rules are inferred to account for the non-random associations of features.

Non-randomness, then, is the discovery made by chi-square clustering. When put to the purposes of creating units, only the positive correlations are directly important, since the absence of a combination cannot serve as the basis of a group. The significant positive correlations are regarded as “natural grouping,” and the objects which are not part of the significant clusters are treated as anomalous, fortuitous, or intermediate combinations of features. Further examination of the combinations of features using a covert notion of similarity can reduce the unaccounted for or anomalous combinations. On the basis of inspection those combinations which differ from the highly significant combinations in relatively few features may be grouped together with these latter, treating the less significant combinations as atypical or abnormal sub-groups or varieties. Ordinarily, a portion, sometimes substantial, of the original data remains unaccounted for as anomalous or intermediate occurrences.

The parallel of chi-square clustering with paradigmatic classification is apparent. Indeed, if viewed apart from its use in formulating groups of objects, chi-square clustering is nothing more than a statistical summary of the frequency of occurrence of the *denotata* of a set of paradigmatic classes. It is in its use as a means to create units that difficulties arise, first by delimiting units upon the frequency of occurrence of attribute (feature) combinations, which inextricably binds the units to a particular body of phenomena, and secondly by the use of similarity to further group units, which voids the possibility of intensional definition. Insofar as the frequency of association is used to delimit units, the units themselves are the product of happenstance-the product, for example, of which site happens to be known first.

While not structurally part of the method, the general attitude of “discovery” as opposed to construction of units contributes measurably to the difficulties, principally in discouraging the explicit statement of a problem whereby the features chosen can be tested for utility or at least justified. While the mechanics of unit formation are lucid and testable, their meaning is not. Thus not infrequently are the resulting units labeled “natural” or non-arbitrary. Aside from begging the question of meaning and utility, recourse to such labeling can usually be taken as a sure sign that the units have no specifiable meaning, much in the fashion that intuitive classifications are often called “descriptive.” As for being non-arbitrary, it is difficult to imagine a device based upon paradigmatic classification to be any less arbitrary than that classification, if not even more so.

One further aspect of groups obtained by means of chi-square clustering which may not be initially apparent, but which is of fundamental importance, is the requirement of a bounded, finite sample. Since the group is an aggregate of phenomena, it must have temporal and spatial boundaries, if only past time and known space. Such boundaries are required for chi-square sorting for the coherence of the clusters. Insofar as “definition” of such a group is possible (either intensional definition where the classification is overt or enumerative definition where the classification is covert), the definition is in large measure a direct function of the boundaries of the sample and not its formal characteristics. If any new data are acquired, both the expected and the observed frequencies of combinations of features change accordingly, and with this the difference between the two calculated as units of standard deviation upon which the significance of the groups is based. Axiomatically the set of groups is restricted in application to the set of data which they comprise. The difficulties which obtain in attempting to employ such clusters for anything more than a statement of the observed distribution of *denotata* over a set of classes in a given case will be treated in some detail in the second half of the book. It should suffice here simply to point out that any confusion between groups obtained by chi-square clustering and classifications is one on paper, for the units are so widely and fundamentally different that if the units are actually employed any similarity disappears.

## Numerical Taxonomy

While “statistical clustering” begins with features and formulates groups as associations or bundles of features that co-occur, the method here termed “numerical taxonomy” begins with the total set of phenomena to be grouped and in essence compares the constituent entities (Operational Taxonomic Units -OTU's) with each other formulating groups on the basis of similarity. In this respect there is an obvious parallel to taxonomy proper which begins with the field, analogous to the set of phenomena in numerical taxonomy, and divides and subdivides the field into classes. While numerical taxonomy, at least in primitive forms, has been employed in prehistory for thirty years or more, there is renewed interest in the application of the more explicit and sophisticated numerical taxonomy developed as an alternative to sloppy use of taxonomic classification in the biological sciences.

There are a number of methods, and it can be expected that the number will grow, given serious interest, which make use of similarity and which can be used to create units. For the purposes of illustration, numerical taxonomy making use of average linkage between operational units will be considered because it is currently the best candidate for application in prehistory as a means of creating groups, and is the simplest form of these similarity-based devices.

All of the similarity-based devices must begin by comparing in one manner or another all of the entities making up the set of phenomena to be grouped in terms of features. Similarity is assessed in terms of sharing of features between entities and expressed numerically as a coefficient of similarity. While some methods require one or another kind of coefficient, most are amenable to a variety of kinds. Thus the particular coefficient of similarity varies not only with the kind of device being used, but also with the ease with which it may be computed for a particular set of data or simply with a preference on the part of the investigators. The Brainerd-Robinson coefficient of agreement is perhaps the most familiar to archaeology. As noted in discussing the notion of similarity, the more features upon which an assessment of similarity is based the finer the discriminations possible. The practitioners of numerical taxonomy admonish the use of as many features as possible, not only to increase the fineness of discrimination but also to avoid “favoring” any one kind of characteristic-a pragmatically useful, but theoretically naive, proposition.

Coefficients of similarity are usually and conveniently expressed in a matrix in which each object or event is represented as a row and a column. The intersection of each row with each column is occupied with a coefficient expressing the similarity of the intersecting pair. The intersection of the row and the column representing the same object, of course, has the highest coefficient since it represents identity. There is an axis running diagonally through a matrix of these coefficients of similarity representing the comparison of each object with itself. All the information of a matrix is contained in half of the comparisons, on either side of the axis of identity, though for some purposes it is convenient to use the entire matrix. Numerical taxonomy is one of several methods of examining and reordering such matrices.

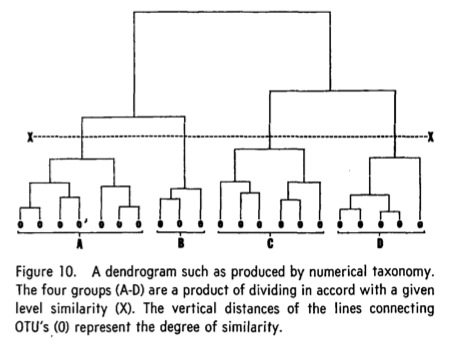
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Figure 10: A dendrogram such as produced by numerical taxonomy. The four groups (A-D) are a product of dividing in accord with a given level of similarity (X). The vertical distances of the lines connecting OTU’s (O) represent the degree of similarity.

The basic procedures in numerical taxonomy begin with the inspection, either visually or with the aid of a computer, of the matrix for the highest coefficient not on the axis of identity and the pair is joined as a first-order cluster. The procedure is repeated until one of the units involved in a coefficient has already linked with another. Here a choice is presented. The first-order clusters may be linked directly on the basis of highest similarity of any one member with any one member of the other cluster. More common, though more complicated, is the average linkage method in which the mean of the similarity coefficients of all members of the previous cluster is computed and the new unit added only if this mean is higher than any other coefficient in the matrix. The procedure is continued, linking previously unlinked units in descending order of the coefficients or in terms of the highest average coefficient if previously incorporated in a cluster, until the entire set of phenomena is linked into a single cluster. The series of linkages can be conveniently recorded in “dendrograms” resembling taxonomic hierarchies (Figure 10). Beginning with any branch, the history of linkages with other units can be traced through the last linkage, uniting all of the units into a single cluster. At this point, however, there is only the total set of phenomena which were to be grouped and the constituent members of the group which is just what you started with. The record of linkages made, however, provides the basis for segregating groups, and, since linkages are made in serial fashion, segregation is always potentially hierarchic. Groups may be created by vertical divisions based on the coefficients of similarity so that clusters with linkages above X value can be considered first-order groups; those above Y but less than X, second-order groups; and so producing a series of groups bearing a superficial resemblance to a taxonomic classification. Of course, unless some specific relationship between a given value for a coefficient of similarity and problem can be demonstrated, such grouping is entirely arbitrary in the common sense of the word.

Another means of formulating groups is to inspect the dendrogram for disjunctions in degree of similarity and divide groups at these disjunctions irrespective of a given absolute value for the coefficients of similarity. Breaking the large cluster into groups which are internally quite similar relative to other such groups may initially seem to produce “natural” groups, and in a sense they are “natural,” but only so within the finite set of phenomena grouped. Irrespective of the means chosen to formulate the actual groups, the set of groups is bound to the given set of phenomena. Any additional data will change the composition of the groups, may alter the order of the linkages, and, particularly in the second kind of group formulation, change the entire pattern of groups. Definition presents serious problems too. Intensional definition is impossible for the members of any group may or may not have a common set of distinctive features. Indeed, as indicated in Figure 8, they may have no common features. Hierarchic structuring of numerical taxonomic groups is a function of choosing to break groups by level of similarity. Those formulated by breaking clusters at disjunctions are not necessarily hierarchic in relation to each other. The meaning of the groups obtained in either fashion is problematic. Without an overt classificatory basis, there is no means of assessing what similarity or resemblance means in a given case, whether or not it has been assessed Ln terms relevant for a given problem. With the tendency to polythetic treatment of features, alternative means of assessing similarity beyond using different kinds of coefficients are not usually considered; yet obviously, if the coefficients were based on an entirely or only partially different set of features, the entire structure of linkages in terms of the coefficients would be different, and thus the groups different. As in the case of statistical clustering, even enumerative definitions of the groups resulting from numerical taxonomy are in part a direct function of the boundaries of the set of phenomena grouped and not their formal characteristics. If at random half the units grouped were removed, the linkages would change; or if the number of entities treated were doubled, the linkages would change, and any change in the linkages would produce an altered set of groups. Thus, like statistical clustering, serious limitations are placed on numerical taxonomy as a means of creating units simply because the end products have the characteristics of groups. By virtue of employing the notion of similarity, numerical taxonomy has further limitations not necessarily imposed upon statistical clustering. Statistical clustering has a basis in paradigmatic classification, and, when this is overt, clusters can be given meaning; numerical taxonomy lacks a classificatory basis, having only a covert analytic step resulting in the features used in assessing similarity, and thus cannot be given any meaning beyond the rather vacuous label “natural.”

## Identification Devices

This kind of non-classificatory arrangement can be conveniently separated from other kinds of arrangement in that identification devices are not a means of formulating units. As such they lie outside the general classification presented in Figure 9. Identification devices are of concern here only in that: (1) they superficially resemble both classificatory and grouping systems because they are comprised by ordered units and thus are easily confused with these kinds of arrangements; and (2) they constitute a major means of actually employing other kinds of arrangement.

The aim of an identification device is the assignment of events or objects to categories that are established through some other means. Given that groups are restricted in application to the data from which they are derived, it follows that identification is a notion applicable only to the articulation of classification and phenomena. The term identification device is thus to be understood as any formal structure designed to assign events or objects to previously defined classes. Bridging the distinction between ideational and the phenomenological, identification devices are highly variable in many of their formal characteristics. They must be adapted to specific data and classifications that they serve to link. Nonetheless, all have more or less the form commonly called keys. Of importance here is the general nature of such devices and the role they play, enabling one to distinguish them from the formally similar unit-formulating arrangements. This is perhaps best done by examining the construction of a key for a paradigmatic classification.

Figure 11 shows a hypothetical paradigm of three dimensions each comprised of three features with a root, I, a permutation of which yields 27 classes, each of which is denoted in the diagram by its definition written at the right. Many more classes than actually have *denotata* are generated; in this case only 11 classes have *denotata*, those marked with boxes to the right. If a new object were to be assigned to this classification, its features would have to be compared until it was matched with an identical definition. This is obviously inefficient. The key presented in Figure 12 represents a more efficient way to locate the appropriate classes for a given object. Through an ordered set of binary oppositions, those specific classes which have *denotata* can be quickly located. By examining the new object for each feature in the order in which those features occur in the key, the unprofitable comparison of the objects with inappropriate classes is avoided, and the investigator is led directly to the proper assignment. The ordered set of oppositions is simply a summary of what is known about the occurrence of *denotata* with respect to distinctive features and excludes all information in the paradigm not relevant to the assignment of objects. By means of binary opposition, keys can facilitate the identification of objects with taxonomic classes even though these are more elegant than paradigms. The utility of identification devices increases with the complexity of a given classification and the number of possible class assignments. It is particularly useful for paradigms which generate a much larger number of classes than actually have *denotata*. Obviously in those cases in which the classification is simple and the number of possible. assignments small, the time and effort involved in constructing an identification device is not justifiable, for there will be little appreciable increase in efficiency of identification.

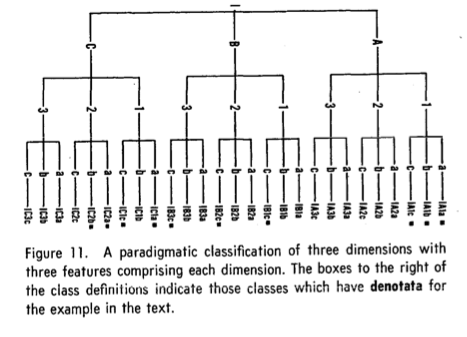


Figure 11. A paradigmatic classification of three dimensions with three features comprising each dimension. The boxes to the right of the class definitions indicate those classes which have *denotata* for the example in the text.

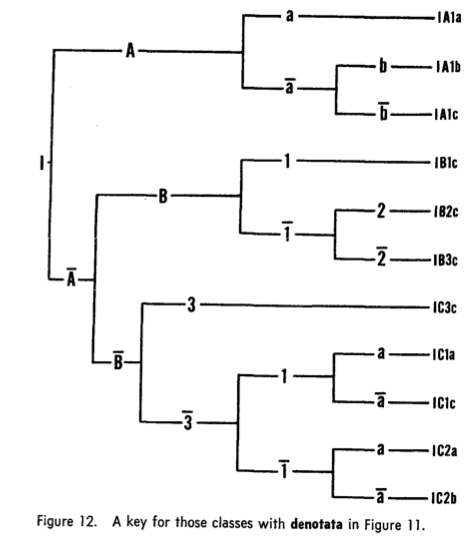


Figure 12. A key for those classes with *denotata* in Figure 11.

Since binary oppositions are employed, the key can be considered dimensional; however, the number of dimensions (equivalent to the number of oppositions) bears no direct relationship to those of the parent classification, nor need the features within a given dimension be the same. For example, in Figure 12, if a given object displays Feature 1 it necessary only to distinguish Feature a rather than a, b, and c. If a is the quality of opaqueness, b translucence, and c transparency, it is necessary only to ascertain whether or not an object displaying Feature 1 is opaque to assign it to the proper class. Without the key, all new objects would have to be segregated into opaque, translucent, and transparent, for in some cases all distinctions are required for proper assignment. When diagrammed, identification devices resemble classifications; however, this similarity is superficial. Identification devices provide only a series of steps to rapidly identify an object. The classes are not defined within it. A comparison of Figures 11 and 12 will show that the class definitions cannot be derived from the oppositions used in the key. Further, there is no universal set of distinctive features. As is the case with taxonomies, the parsimony of the paradigm has been lost in achieving a more elegant system. In contrast with taxonomy, keys, such as portrayed in the example, do not necessarily have fixed, non-permutable order. In the hypothetical key, the last two oppositions in the branch leading to classes. 1C2a and 1C2b could just as easily be reversed with no alteration made in the identifications or in the efficiency of the scheme. Whether or not the order in a given key is fixed is not a function of the key itself but of the definitions of the classes for which it provides identification.

While identification devices are not bound to any specific set of phenomena by virtue of their ideational element, they are restricted to phenomena assignable to classes previously known to have *denotata*. If an object assignable to a paradigmatic class not represented in the key were to be identified using the key, it would be given an assignment not in agreement With the class definition. Because such an object is given an unambiguous assignment such misidentification easily escapes detection. For this reason, identification devices are best used upon kinds of data which are well known. If the oppositions used in the key are not of the A/A kind, that is, mutually exclusive and exhaustive, misidentification will be replaced by ambiguity or no identification, which in turn permits detection of the new class member.

Keys or identifying devices can be constructed for any kind of classification and are restricted to classification; however, unless so doing increases the efficiency of identification over comparison with class definitions, there is little point to their construction. They are not a necessary adjunct to classification, though they can be exceedingly useful in applying complicated classifications. Undoubtedly the greatest problem found m scientific literature involving the use of keys is the substitution of a key for a classification. When the classification on which a key is based is not made explicit, either in the mind of the investigator or the work in which it is employed, it is difficult because of their similarity to detect which has been used, a problem especially difficult in written sources. A great deal of misunderstanding and an inability to replicate other workers' results can be a consequence.

## Summary

To summarize non-classificatory arrangement it is well to look at the relationships that this kind of arrangement bears to classification. In many formal aspects all arrangements are similar. All involve units or categories of one sort or another. All provide some kind of structuring between such units, and the structuring, together with the units, appears as a system. Similar graphic devices as well as similar language can be used to present and manipulate all kinds of arrangements. Thus it is a simple matter to confuse one kind of arrangement with another, especially if the explication is less than complete. A comparison of the various kinds of arrangement shows that the consequences of such confusion can be serious indeed, and in many cases difficult to detect.

The initial problem faced by the student is the identification of the various kinds of arrangement as they are expressed, often covertly, in the literature. Classification can be distinguished by: (1) the lack of objective existence of the units giving them an ahistorical character and permitting the similarities occurrence or sharing of their *denotata* recognizable as distributions only classes can have distributions; and (2) the ability to provide intensional definitions for the units. Not a feature to be found in every case, but one of utility in recognizing classifications, is the presence of specifiable problems to which they are directed. Grouping devices may be readily identified by: (1) the fact that the units always consist of aggregates of objects or events with locations in time and space; (2) the ability of the units to include additional members without redefining; and (3) “definitions” which derive from the historical boundaries of the sample used in the original formulation and which take the form of enumeration or summary of the content of the units. Identification devices are easily distinguished in that they have neither members nor definitions. Classes are all form, groups are all content, and identification devices have neither (or both, as you care to view it).

These clues to the various kinds of arrangement only partially permit identification, for when investigators have not maintained such distinctions in their work they often will shift from one form to another as a matter of convenience. This is certainly true, as will become apparent, for prehistory and its literature, and it means that each work must be carefully examined for consistency in matters of arrangement.

Since the focus of our concern is the creation of units and not their manipulation and use, identification devices can be disposed of quickly, for they do not formulate unit nor is it likely that they can be confused with unit formulation. Their relationship to classification is simple and direct. they function to aid the identification of new objects or events with previously established classes. They are useful when and only when: (1) the classification is large, and there are many possible assignments; (2) the number of classes without *denotata* is large: a - d (3) the body of phenomena being identified is well known for its general characteristics.

The relationship of grouping devices to classification is likewise simple but not nearly so obvious. Class *denotata* once assembled by identification always constitute a group; however, it is quite different from grouping objects or events to construct units. Statistical clustering has a fairly patent basis m paradigmatic classification, and, the claims of its users not withstanding, it simply selects some of the paradigmatic classes as important in a given historical case. Further, less Important classes (numerically) may be merged with the important ones utilizing covertly the notion of similarity. Both the selection and merging are based upon counts deriving from a particular set of data, and it is just this feature which limits the utility of statistical clustering. Groups so produced cannot be defined. save by drawing a line around them-they are what they are simply because they are. Such clusters have locations in time and space and cannot be used to measure variation in either dimension. To attempt to employ such units in an examination of variation is not terribly unlike measuring with a rubber yardstick of continually varying calibration. These criticisms apply only to statistical clustering as a means of creating units. If the underlying classification is explicit, these same procedures result m a statement of the frequency of occurrence of the *denotata* of a classification in a given historical case, evaluated in terms of the sample size. Such procedures have demonstrable. Utility in manipulating classes and in formulating and testing inferences about their behavior. The kind of grouping device termed statistical clustering” cannot be regarded as a legitimate means of unit formulation, but it is a highly useful means of manipulating previously formulated classificatory units.

The relationship of numerical taxonomy to classification is less obvious. The notion of similarity is the basic point of difference, for there is no question that numerical taxonomy can formulate units. As with other kinds of grouping, however, there is no way to discover, at least programmatically, what the groups mean relation to a problem. The units so produced as groups are subject to all the criticisms voiced of statistical clustering. The meaning, the kinds of inferences which may be based upon such units, is problematic and intuitive (thus the labels “natural” or “descriptive”). The situation which has given rise to the development of numerical taxonomy, the abuse of taxonomic classification, is certainly in need of correction however it is difficult to see how a similarity based group of bones is an improvement. The context of its recent development does provide a key to its relationship with classification. If treated not as a means of creating groups, but as a means of treating the *denotata* of pre-existing groups, a useful relationship with classification can be stipulated. In this case numerical taxonomy summarizes' the occurrence of both distinctive and non-distinctive features over the *denotata* of a classification. As in the case of statistical clustering, numerical taxonomy provides a valuable means of manipulating class *denotata* and formulating and testing inferences about their behavior. With an overt classification establishing the groups, the arbitrariness in breaking groups at levels of similarity or using disjunctions in the sample is eliminated. The notion of similarity functions quite adequately in the realm of finite historical data but cannot serve as a means of creating units to frame ahistorical laws governing the behavior of phenomena.

Classification remains the only legitimate means of constructing units for scientific purposes. The procedures used in grouping devices, while not useful for the construction of units are useful in the manipulation of class *denotata*. Identification provides the means of creating groups of utility. The development of grouping devices as substitutes for classification is a function of the misuse and poor explication of classificatory systems.

With a few notable exceptions, the new archaeology employs the methods described here as grouping devices in their proper roles as means of stating and correlating the occurrence and distribution of *denotata* of otherwise defined classes. Archaeology’s predilection for borrowing from other disciplines does not bode well in this respect, for particularly in the biological sciences have grouping devices gained some currency. The temptation to employ these mechanically lucid devices to create units is deceptively enhanced by their explicit accounts of what is already known. Where they fail is less obvious; they cannot be employed heuristically, and they are not testable in any meaningful sense beyond their mechanics.