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A Procedure for Public Involvement

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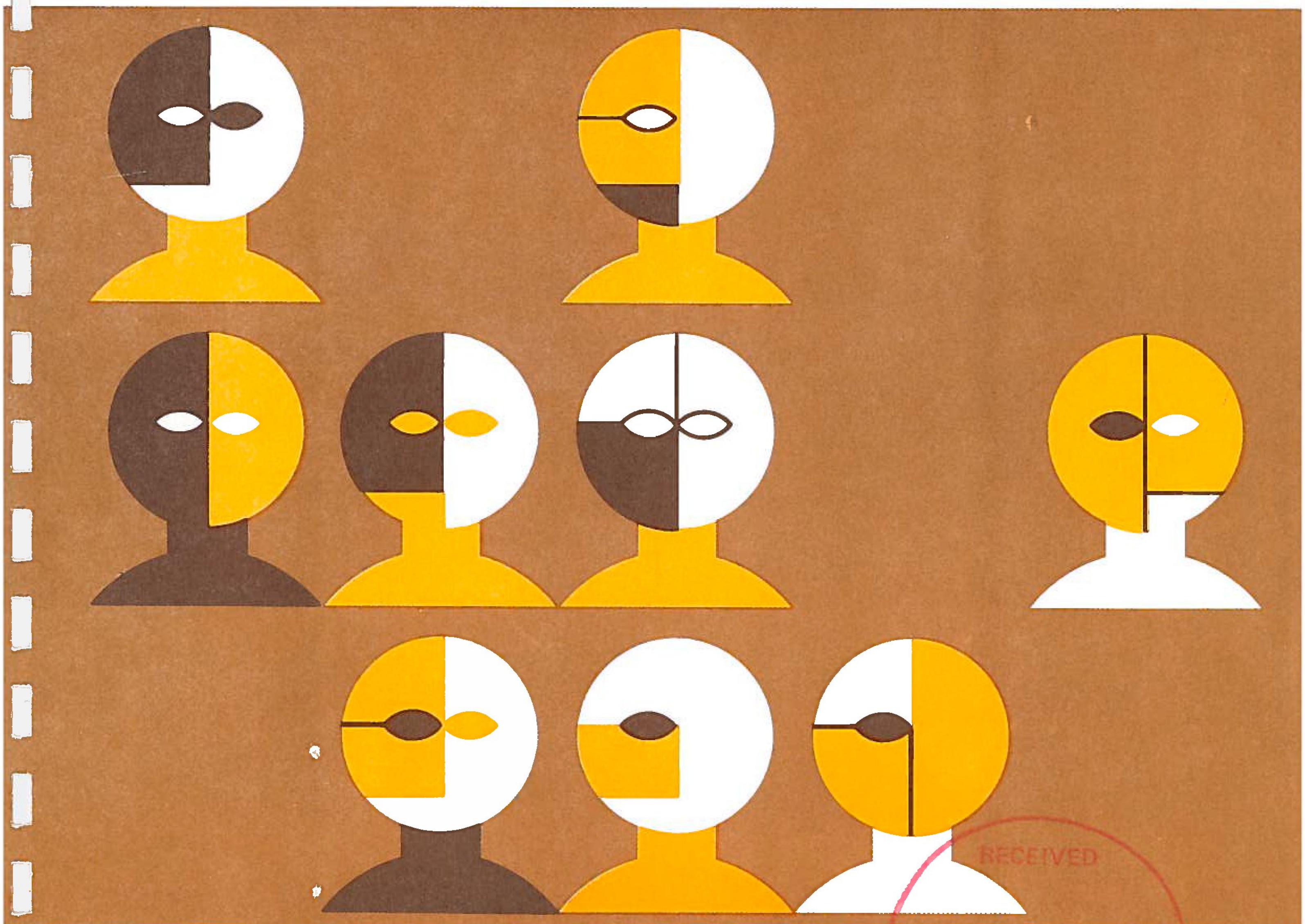

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"PUBLIC - A PROCEDURE FOR PUBLIC INVOLVEMENT"

Pamela J. Case, Terry D. Edgmon, and Donald A. Renton

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ABSTRACT

This report is a concept paper and user's guide for PUBLIC, a collection of quantitative procedures designed primarily for use by public agencies who are attempting to heighten and improve the public input into their decision processes.

Recent changes in public attitudes concerning administration of publicly owned resources have considerably altered the decision environment of resource administration agencies. This report reviews some basic relationships between administrative agencies and communities in the goal setting process of public land planning, and survey research techniques by which economic and social values can be better expressed with regard to land management alternatives.

Although professional public agency administrators recognize that public input into the decision processes of the agency is necessary and even desirable, there is general concern over how to utilize public input in a clear and straightforward fashion, and also a concern about how to maintain competent professional input simultaneously with public input. The PUBLIC procedure outlined here attempts to clarify the collection and analysis of public opinion data, and also shows how such data can be utilized to examine the correspondence between agency staff specialists and various public opinions in such a way that professional advice and public opinion can be more harmoniously meshed.

This report also includes a description of how to utilize the various computer programs, which are primarily multivariate statistical techniques, included in the PUBLIC package, and a listing of the computer programs and example problems. The programs have been developed in American National Standards Institute FORTRAN IV and should be operable on any computer with a FORTRAN IV compiler.

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CONCEPTS

Since their creation, natural resource management agencies such as the Forest Service, the Bureau of Land Management, and some state agencies have often included grass roots participation in resource planning and decision making. Although there have been times of conflict, these agencies have often enjoyed close and supportive relations with significant interest groups and the general public (Fairfax, 1975).

One major reason for such close relations lies with the fact that the clientele of these resource agencies have been groups whose economic livelihood coincided with the viewpoints of managers of the public lands. Within a common framework of production orientation (with the exception of management practices within wilderness areas and national parks), conflicts among user groups and agencies have tended to be about management procedures rather than about goals. For example, the fact that grazing fees exist has not been a significant and overriding issue; the amount of the grazing fees and by whom they are set have been more the focus of conflict.

A common set of goals or preferences concerning administration of natural resources and communications networks which link private enterprises to public agencies has led to the integration of public and private resource decision making. User group (or community) advisory boards have served to legitimize agency action on the local level. This atmosphere has allowed a decision environment which apparently met the test of grass roots administration of publicly owned land, while at the same time it allowed the manager to meet agency objectives and to use techniques which have promoted economic efficiency in development and utilization of natural resources.

However, recent changes in public attitudes concerning administration of publicly owned resources and the creation of new and powerful environmental interest groups have considerably altered the decision environment of resource administration agencies. For example, during the latter 1960's and early 1970's, the word "ecology" entered the public's vocabulary, and committed individuals have organized to pressure the resource agencies to modify their established policies and decision making procedures. A manifestation of the impact of these environmental groups is the National Environmental Policy Act (NEPA) which authorized creation of the Environmental Protection Agency to safeguard significant environmental preferences, and required an "environmental impact assessment" for projects with federal sponsorship. Environmental groups have gained access to decision making processes of resource agencies and brought court action for decisions alleged to be in conflict with the NEPA legislation (Ingram, 1973).

These trends have drastically altered the public land manager's decision environment and created the following problems:

(i) Reliance upon advisory boards composed of traditional user group representatives has led to some administrative decisions which have not gained support of the community as a whole.

(ii) The demand for non-economic uses of public land has been difficult to identify and reconcile with economic land uses.

(iii) Decisions found to be politically unacceptable have led to costly court proceedings and disruption in orderly public land planning and resource allocation decision making.

Helpful procedures for public land use managers who find themselves in the above situation include:

(i) understanding the varieties of public land use preferences held by various elements of the public,

(ii) developing an administrative system by which citizen conflicts over public land use values can be interpreted and goal consensus can be achieved, and

(iii) developing an analytical technique which considers non-economic preferences along with economic ones in determining public land management strategies.

This report reviews some basic relationships between administrative agencies and communities in the goal setting process of public land planning, administrative procedures which can help to develop goal or value consensus among competing groups, and survey research techniques by which predominant economic and social land use values can be utilized in acceptable land management strategies.

THE PROBLEM OF GOAL IDENTIFICATION: ORGANIZATION AND COMMUNITY

The most difficult part of a land management plan always seems to be: "What are the goals for this plan?"

There are several ways that an agency can resolve this question, and the manner in which it does is usually determined as much or more by organizational structure and forces outside the organization as by the nature of resources being allocated. For example, a land area which is generally inaccessible to the general public can be managed on the basis of internal organizational criteria, i.e., attaining goals in line with national policy and exploiting or husbanding resources in accordance with the prevailing expertise of the professional staff. The agency is generally free to establish almost any pattern of land use, consistent with national guidelines, that it wishes.

A more common and more complex situation is that where the land may possess many significant resources. For a multiplicity of uses, there may be organized groups which have a vested interest in the way that the public land is managed, in the productivity of that land, and in the consequences of its development and exploitation. In this situation, the land manager's goal formulation problem is more complex, and diverse interests and preferences must be reconciled before more technical aspects of land and resource planning and implementation can get under way.

<u>Hierarchical Approaches to Goal Identification</u>

Classical theories of bureaucratic organization, such as those developed by Weber (Gerth and Mills, 1946) and Gulick and Urwick (1937), state that the agency goal setting process occurs outside the organization in political institutions such as legislatures, the offices of the chief executive, and advisory boards or commissions. Goals or statements of purpose are then transmitted to the agency or department in the form of enabling and authorizing legislation and executive orders. Top level agency personnel then take such mandates and devise rules which, if followed by personnel lower in the agency's hierarchy, will optimize the values embodied in the goal statements.

The basic assumption behind classical organization theory is that authority is delegated to the organization from political or policy-making bodies. Personnel at the bottom of the pyramid base their decisions upon formal rules, and a structure of incentives and disciplinary procedures insure the accountability of agency personnel to formally stated goals.

This theory of organization is reflected in the formal hierarchical structure of many agencies and bureaus in the United States. Formal agency accountability is supposedly insured by executive and congressional control. However, this system of authority may break down if the policy-making or goal formulation body, such as the Congress, either articulates very general or inconsistent goal statements.

Formally stated goals may follow from the function of the organization, i.e., to justify the organization to important elements in the organization's environment. These statements are usually very general and can be used to legitimize categories of organizational behavior and contribute to flexibility of the organization. For example, an agency's claim to be the protector of public resources for use by future generations may be seen as a justification for granting it the autonomy to determine current resource management practices.

Consensual Approaches to Goal Identification

Other organizational viewpoints recognize the deficiency of top-down mechanisms of goal formation. Formal organizational goals run the risk of being displaced or substituted if they do not meet the needs of the participants or if they do not contribute to organizational growth or survival. Alternatively, a bottom-up organization requires consent of personnel or constituents at the bottom of the organizational pyramid. This distinction is critical in that it allows claims by organizational personnel in the goal setting process. Authority through consent is reflected in the utilization of participatory programs and granting of decisional autonomy to organizational units operating in the field.

In both the hierarchical and consensual procedures, organizational goals are statements of desired future states or preferences to be achieved by organizations. In the consensual procedure, however, there is general internal agreement that these goals are both legitimate and attainable. Consensual organizations also recognize that different goals are pursued by different participants in the organization.

A principal character of consensual organizations is the interdependence of individual participants with different goals, each working toward the attainment of some portion of his goal set. Organizational goals therefore can be viewed as an amalgam of particular goals, but no formal weighting process exists and everyone does not have an equal voice. The effectiveness of different participants in the goal setting process depends on the resources each participant brings to that organization. We can view the organization thus as a coalition, with the various participants making contributions through their personal resources and those which they can mobilize outside of the organization. Organizational goals therefore are determined through a bargaining process which establishes the dominant organizational coalition.

In practice both top-down and bottom-up activities take place and successful organizations utilize both approaches in a process which allows vertical iterations between levels of a hierarchy to arrive at a mutually agreeable course of action (Mesarovic, Macko and Takahara, 1970).

Community Goal Identification

The coalition approach to goal setting is particularly important in complex organizations and the public land planning process, especially in resource areas where the price system cannot be relied on to indicate the public's (or consumer's) land use preferences. Several differences between public and private organizations which make the coalition-bargaining process in goal setting imperative are:

(i) Private organizations in a market economy usually receive resources from clients or customers who can choose to provide the organization with resources (or inputs) in exchange for its outputs. Public organizations, however, may serve customers in legislative bodies who "purchase" through budget allocations services and products for clients in the social system. Thus, the input of fiscal resources is separated from the service or product output function; the evaluation function is divorced from the market process and is conducted through a political process.

(ii) Public organizations usually deal with complex technologies and outputs that cannot be subject to precise quantifiable evaluation. Subjective but important environmental resources such as scenic beauty and the quality of outdoor experiences may be subjects of concern, but are difficult to evaluate in conjunction with quantities of timber cut or ore mined.

(iii) Public organizations must mobilize critical organizational resources from many points in the social system (Table 1). On the other hand, private organizations must look primarily within themselves for resource mobilization.

If each of these different constituencies--the subcommittees of legislative bodies, interest groups, advisory boards, professionals, and career civil servants--possessed similar expectations for the agency, then the goal identification process would be a simple affair and resource mobilization would soon become routine. However, these different constituencies usually possess different expectations and establish conflicting demands for agency action in return for resources needed by the agency.

Since the community decision process is diffused among many units of government and organizations, communities generally experience a greater level of conflict over formulation and execution of common goals than do bureaucratic organizations composed of individuals who share similar preferences and educational experiences, and who have consented to accept subordinate roles in an organizational hierarchy.

It is important for public land managers to understand the social and political processes related to community goal setting, not only because laws dictate that local citizens and groups must participate in planning decisions, but also because local citizens and groups may possess resources critical to the success of the public land management agency. Agency decisions may have significant impact on the social and economic order of the community; economic and political interests of local communities may in turn be able to exert considerable influence over the management of public resources available to their community. Either by challenging the legitimacy of a particular agency decision, or withdrawing political support for a particular policy, organized groups in local communities may have the potential to block or negate even the most meticulously prepared public resource plan.

Table 1. Organizational resources, utilization and sources for a land management agency.

Resource	Utilization	Source
Authority	Legal basis for action	Legislative subcommittees, the executive office
Legitimacy	Participation and client's consent to exercise authority	Citizen advisory board or advisory groups.
Political support	Mobilization of attentive public to facilitate the organization's goal attainments	Environmental user groups
Fiscal resources	Revenues to sustain the organization	Congressional subcommittees, Office of Management and Budget
Technology, knowledge, problem-solving skills	Application of knowledge to produce organizational outputs	Professionals, professional societies, universities
Administrative systems	Coordination, control and maintenance activities	Administrative staff

To examine the community goal setting process in more detail we will look at aspects of (i) conflict issues, (ii) configurations of interests, (iii) distribution of power resources, and (iv) distribution of formal authority.

Conflict Issues. Whenever a community becomes engaged in goal formation and implementation, three basic types of conflict issue may emerge: (i) statements of outputs to be achieved, (ii) the means to implement certain goals, and (iii) the structural relationship of interest groups and agencies in the decision process.

Conflicts over output preferences are exemplified by struggles between environmental protectionists and those who directly depend on the development or utilization of natural resources for an economic livelihood. Each group prefers different outputs from the system. In this case compromise over the alternative means of resource management will be very difficult. A group will not feel that it has "won" until it perceives that the goals of the agency have been modified so that they are more consistent with the group's preferences. The win-lose character of this sort of conflict over agency or community goals implies that "political" solutions must be implemented before the more technical planning processes can be meaningful.

Conflict over the means to implement goals may be addressed after a basic consensus on preferences is reached, thus allowing conflicting parties to interact to achieve agreement on an appropriate course of action. An example of this type of issue is one where differences of opinion exist over the amount of land and kinds of treatments applied to the land in a wildlife management program. The resource manager may engage in a series of negotiations until many alternatives are examined and a mutually acceptable strategy is agreed upon. Negotiations over alternatives are not very meaningful, however, unless a basic consensus on goal statements has been achieved.

Conflict involving changes in structural relationships of organized groups to agency decision making is involved in the change in interest group-agency relations created by the Environmental Impact Assessment process. Environmental interest groups marshalled sufficient power and influence on the national level to pass legislation which required comprehensive review and evaluation of federally sponsored actions that have implications for environmental change. This legislation gave citizen groups, through court action, the ability to veto or raise the costs of resource development decisions not initially included in the decision and planning process. Again, this type of conflict usually renders analytical or planning solutions useless, as the real issue involved is not the allocation of resources but who will determine how resources are allocated.

Configuration of Interests. The second important factor which may affect the community goal setting process is configuration of interests or preferences in the community. In some communities, there may be small differences and a relatively high level of agreement among citizens on resource preferences. An example of a community with a high level of consensus would be a small rural community with most of its work force dependent on utilization of publicly held resources. In other communities, however, there may be a fragmentation of interests and a relatively low level of agreement among citizens or groups on resource preferences. These communities tend to be metropolitan areas with more diversified economic bases and subpopulations pursuing divergent life styles.

Distribution of Power Resources. The third important variable in community goal setting is the distribution of power resources among community interests. This refers to the level of organization of interests within a community. In American society, power resources which can be utilized to affect political and administrative decisions can be most efficiently mobilized by organizing individuals who share some preference order or are pursuing a common goal. In this sense, organized groups are continually working to get elements of the unorganized public either to implicitly support their causes or to participate in their achievement.

In communities there can be varying degrees of organization for different interests. Some communities may have only a few organized groups or leaders, while in other communities many may be competing with each other to influence public decision outcomes. In communities with populations holding broad agreement on a wide variety of preferences, only a few individuals are needed to determine public policy. However, in communities where broad agreement on many preferences is lacking, many organized groups will be competing with each other for dominance in the public decision process. In this case many more leaders will be needed to determine public policy.

Distribution of Formal Authority. The last significant variable that affects the community goal identification process involves the distribution of authority in implementing planning goals. In some cases, the legal authority to plan and then execute that plan resides largely in one organization or branch of an organization. More commonly, however, resource allocation authority is shared by a number of governmental agencies or their branches and among levels of governments. This is particularly true in region-wide environmental planning that requires coordination among federal, state and local governments. Success of regional planning, therefore, lies in the identification of the roles that various agencies or their branches play in implementing the regional plan.

ADMINISTRATIVE SYSTEMS

The level of effective planning and management is related to the roles which the administrative system plays in the community goal setting process. A role is defined as a set of behaviors initiated by an individual or social actor in response to a set of expectations in the individual's organizational environment. These roles, in turn, can be aided or hindered by the formal organization within which the planner works.

The individual who occupies a formal organizational office has two basic criteria for determining what he shall do in that office. The first criterion is established by a formal delegation of authority assigned by the organization or other institutions. The second criterion for defining organizational roles lies in expectations of other individuals. Simply stated, whenever an individual assumes a new organizational office, he must learn more than the formal job description if he is to be effective. He must also learn the unwritten job description as it is defined by his colleagues.

In the community goal setting process, the planner or manager may not be able to significantly alter expectations of those within the community, because he may not possess the power, influence, or authority to do so. Moreover, these conflicts in expectations by others may be based upon different groups' expectations of the organization itself. For example, user groups may expect the organization to develop plans to help them solve problems of resource development or utilization, while environmentalist groups may expect the organization to develop plans to safeguard those same resources. They then would expect the planner to act accordingly.

An administrative system in which roles as defined by the formal organizational structure are consistent with roles as defined by community expectation naturally has the best chance of achieving consensus and effective managerial action. Thus an appropriate balance between the needs and preferences identified by agencies or agency branches and the community is a great asset in achieving a widely acceptable plan of action. An efficient administrative system recognizes that goal identification in the public land management planning process is based on the interdependencies and interaction of the agency and specific reference publics.

The goal identification process has to be more than a way to aggregate individual citizen preferences. The process also has to develop community legitimacy and group support for the goals that finally emerge if the agency hopes to implement the plan with a minimum of agency-community conflict after the planning process is completed. Therefore, goal identification can proceed only if elements of the public become mobilized and organized in such a fashion that they may address themselves to the issues contained in the plan.

The basic problem for the public land manager is that different community groups or reference publics may possess different expectations about what specific natural resource values shall be emphasized in any given plan. If the level of group influence is proportional to the number of citizens who agree with the interest group's goals, then the goals selected would be those preferred by a majority of the citizenry. In most cases, however, the interest or capacity of any given organized group to alter or change agency planning goals is not proportional to the sheer number of citizens who possess preferences similar to the organized group but also depends on the activity level of the group.

Public administrators must seek objectives which tend to maximize the general welfare rather than the interests of specific organized groups. The planning and goal identification process should combine interest group activity or potential activity and analysis of citizen preferences in a way that allows for trade-offs among interest group, agency, and individual preferences.

<u>The Role of Staff Specialists</u>

Land management alternatives can be identified in many ways. Initially a planner or manager may identify a large number of alternative management options. This list can then be subjected to evaluation by landowners, users, and managers for deletion and addition of alternatives. For analytical purposes the number of alternatives must be reduced to the smallest practical number. Special interest advocates must also be able to add or delete some management alternatives.

The functional staff of large agencies may create biases toward particular resource uses. As resource professionals are technically trained in specific fields and focus attention on technical management problems, they gradually become less aware of the social changes occurring in their constituency groups. A technical group may therefore have a well defined set of opinions concerning how public lands should be managed. A preference or interest configuration refers to a particular combination of preferences desired by a given set of individuals; in the special case of a line staff organization such as a National Forest or Bureau of Land Management district, the functional areas of professional staff members reflect preference configurations. For example, if the policy of a given land management agency is to be more concerned with timber harvesting than with wildlife management, this policy will be reflected in a greater number of timber specialists than wildlife biologists on the staff of the agency.

The presence of groups of specialists in functional areas in the organization helps to create a stable, long term bias toward specific sets of preferences in day-to-day decision processes. By contrast the interest configuration of the public constituency may change more rapidly. The constituency may be more sensitive than the agency organization to changes in social values brought about through urbanization or rapid alteration of consumer or labor markets.

Therefore, over a period of time, differences undoubtedly arise between the interest configuration of various constituencies and agency personnel. If the conflict of interest between the agency and its constituencies becomes great enough, special interest groups may begin to form and seek ways to force the agency to alter its decision process and to make decisions which are more responsive to articulated constituency demands.

The differing rates of change between the attitudes of the agency personnel and the public constituency have created the arena of conflict. It is therefore essential to develop some mechanisms to allow inclusion of identified management options which are preferred by special interest and staff advocates as well. The Delphi and Delebecq techniques are just two of many procedures which have potential application to this type of problem. These tools could aid in identifying, evaluating and reducing the list of possible management alternatives to the most important land use options to be considered in the management needed.

METHODOLOGY

In the previous section we discussed organizational and community planning goal identification and formation viewed as a political process. By this we mean that individuals and groups usually attempt to promote or defend different interests which may be in conflict with any particular plan. Thus, some mechanism needs to be employed whereby this conflict is resolved or managed so that decisions are reached on issues. Alternatively, representatives may be selected; these representatives then must decide among themselves what shall be the goals of either an organization or a community.

Goal identification for plans must be an integral part of the citizen involvement process. Land use goals created on the basis of preference information must be legitimized by the community, and the planning agency must develop broad-based political support for these goals if they are to be implemented successfully. Appropriate configurations and structures for various interests must also be established. Only when these questions are satisfactorily answered can further details of the planning process proceed with any real meaning.

The purpose of this section is to describe a set of procedures which will assist the land use planner in developing goals which have the potential for acquiring broad political support from the community. In order to accomplish this, the procedures described in this section will provide:

(i) a simple and efficient survey procedure for gathering information about preferences of individuals in a community or region for alternative land uses;

(ii) a procedure for identifying and describing the level of community organization and the types of active interest groups which exist or may emerge;

(iii) an analytical procedure for determining the distribution or configuration of land use preferences within a given population or community;

(iv) an analytical procedure for aggregating conflicting individual preferences into a single agenda or meaningful set of agendas of land use levels and priorities; and

(v) a means of determining the desired level for each land use or suitable range of levels.

In order to incorporate citizen needs and preferences into land use planning, the decision-maker requires the following basic information: (i) identification of a variety of land use items which are salient to the population of the regional social system, (ii) knowledge of the existing or potential activity related to each of these items, (iii) an order of preferences of the land use items, and (iv) knowledge of desired use levels or desired amounts of each land use item.

SAMPLING PROCEDURES

It is assumed here that the only systematic method of gathering information about preferential choices of citizens of the regional social system is by conducting a survey. Questions include: (i) whether to conduct a complete survey of the population or to make use of a sample, and (ii) whether to gather information by means of a mail questionnaire or by interviewing. Two kinds of criteria are commonly used to select among these options: (i) informational adequacy, meaning accuracy, precision and completeness of data; and (ii) efficiency (cost per added unit of information).

The most important characteristics of a well-designed sample survey are that they give a precise picture of the population from which it is drawn, that they be as small as precision considerations permit, and that they be gathered as swiftly as measurement techniques permit. Techniques for designing a sample which meets these objectives can be found in any social science methodology text.

Ordinarily, an investigator chooses between mail questionnaires and interviewing on the basis of both economic efficiency and his anticipated response rate. Mail questionnaires are usually less expensive in comparison with interviews. An interview may cost approximately 5-10 times as much as a mail questionnaire when the population is centralized and 10-50 times as much as a questionnaire where the study population is widely dispersed. A mail survey is appropriate when the questions are few and simple, but interviewing is necessary when the survey topic is complicated, when the questions are unavoidably lengthy, or when the questions require probing. If any of these conditions occurs, the mailed response rate will be extremely low and the economic efficiency of the interview will be superior. In our suggested procedure, we include preliminary interviews to determine preference items and information exchange behavior, a large mail survey to determine preference orders, and a final interview series to determine preference levels.

INFORMATION EXCHANGE BEHAVIOR

To develop a sociometric profile of a community, interviews are conducted with respondents who are asked to nominate other individuals who are influential or frequently communicated with in the community. Emphasis on influence or communication may vary with the purpose of the study. The nominated persons are in turn contacted for their nominees. The process continues until an adequate set of frequently nominated individuals is obtained.

These frequently nominated individuals can be very helpful in determining preference items and definition of preference items to be included in the survey instrument. Because of their knowledge of community affairs, they are often able to identify salient items much more readily than a respondent selected at random.

If a population is sufficiently small that it can be completely interviewed, the questions about preferences can be included in the interview schedule. This provides a much better determination of preference than a sample, but, of course, is limited to small populations.

IDENTIFICATION OF LAND USE PREFERENCE ORDERS

The criteria for identification of the preference set are the following:

(i) these items must be important to members of the population,

(ii) they must be defined in terms of output units rather than management procedures, and

(iii) they must be as few in number as possible.

Because of certain ecological or social properties of the environment in which individuals live, some discriminations are more important to them than others. We define the importance of preference items as *salience*. Individuals usually form preferences only for items which are functionally salient to them. However, the survey may include items which require individuals to state preferences on choices which are of little importance to them. In order to include only preference sets where respondents have explicit preferences, a procedure for evaluating the salience of each land output to the population must be applied before it is included in the set.

Normally, in preferential choice problems, it is necessary that the set be mutually exclusive. Due to the nature of land use problems, however, several types of uses (such as bird watching, rock hunting and cultivation) may occur in the same time and space. It is necessary to determine which of the preferences require mutually exclusive management practices (single-use alternatives) and which require inclusive ones (multiple-use alternatives). Multiple-use alternatives may be expressed in output units, but mutually exclusive uses must be expressed by the amount of land designated for the use.

Although it seems intuitively correct that the rank order an individual gives to a set of three items would remain the same when the same three items are presented to him within a set of five items; in fact, the number of items which must be considered by an individual affects the preference order he gives to them. The probability that an individual will encounter items to which he is indifferent and that he will resort to several interacting selection criteria increases greatly as the number of items in a set increases. In order to simplify the analytical process as much as possible, the system should include the smallest set of items that is reasonable for the nature of the planning problem.

We suggest a three-step process be used for the identification of land use preferences. In the first step the resource manager who initially defines the land use management problem will suggest a fairly large set of items to be included. These items are then pilot-tested for salience and for expansion or reduction with a group of resource managers who occupy administrative or other influential posts. The second step is to pilot-test the list of land use items with a citizen group or panel of knowledgeable community members.

A common test of salience in this context is to require that the new item be important enough to replace one listed in the original set. The first and second steps can be incorporated with the study of information exchange behavior described in the preceding section. In the third step the reduced and refined list of items is used in a community survey procedure. The survey procedure will consider:

(i) the design of response categories for determination of preference order and desired use levels, and

(ii) the design of an efficient sampling method.

<u>Social Choice Patterns</u>

Ideally, the individual responsible for land use planning or decision making would like to know what decision would satisfy all or most individuals in the regional social system. Within ecological constraints dictated by biological systems, a resource manager often strives to satisfy the needs and preferences of resource users. If information about preferences of individuals in the population can be made available through a survey, the resource manager would be able to total the preferences of all the individuals in the social system into a single preference configuration which he could then attempt to satisfy. When the resource manager enlists the aid of an analytical device to help reach decisions, it is even more important that the preferences be in a form easily digested by the analytical procedures. The problem considered here is the aggregation of preference patterns of all individuals into a single pattern which appears to satisfy the majority of the individuals in the population.

Development of a procedure for combining conflicting individual preferences into a single social choice pattern constitutes a major theoretical problem. To give the reader some knowledge of the problems involved and the conditions which must be satisfied by the procedure, a brief review will be made of the major developments in the search for a social welfare function.

In a classic study, Arrow (1951) demonstrates that, given a number of reasonable criteria for the choice structure where there are at least two persons and three or more alternatives to choose from, it is not possible to construct a general social welfare function from knowledge of individual preference orders. According to further work by Arrow (1951) and Luce and Raiffa (1957), this difficulty persists even when the welfare function is restricted so the criterion for an acceptable decision is one which satisfies only the majority of the population.

One of the major difficulties in these procedures is that they restrict consideration of individual preferences to information about the order of preferences among alternatives. When a common mechanism, such as averaging of rank orders, is used to aggregate individual preference orders, the result often is an intransitive majority decision. Consequently, social scientists in several disciplines have felt that construction of a social welfare mechanism might be possible if additional information about the structure of individual preferences could be gathered. One simple way of aggregating individual preferences is to assign weights to each preferential vote which reflect the strength of the individual's desire for each alternative. Thus, if P's preference for alternative A is twice as strong as O's preference for alternative B, alternative A may be allowed to take precedence over B without violating our criteria for a "fair" decision.

As a result of the work of Arrow and others, it appears that construction of a social welfare function always involves two normative judgments. The investigator must make judgments about: (i) the relative weight to be assigned to individuals in the society, and (ii) the relative weight to be assigned to each preferential vote. However, the criteria for the social choice mechanism we are attempting to design here are that normative judgments by the analyst or planner be reduced as much as possible so that a pure expression of community preferences can be attained.

Where strength of preference is used in calculating a social choice pattern, some means of comparing strengths between individuals are required. Until very recently, it was assumed that comparisons of preference could be made only in arithmetic fashion; i.e., an interval or ratio scale must be used. Arithmetically, averaging strengths of preferences over individuals requires the existence of a common unit of measurement for "preference" and an actual numerical estimate of it.

A procedure developed by Coombs (1958) attempts to meet the theoretical requirements for a social welfare function. The primary purpose in outlining

Coombs' work is that it demonstrates problems in psychological choice behavior which inhibit the development and application of a social choice procedure even if the theoretical problems are overcome.

Coombs has shown that a social choice function using the strength of preference notion can be developed within an ordinal measurement model. The technique assumes a common preference measure but does not require that a numerical estimate be made of the preference interval. Assuming that most of the individuals in the population use a single common perception to generate their preferences among the values, each individual and each value may be represented by a point on a common dimension called a *J Scale*. The J Scale is equivalent to the social choice pattern. Each individual's preference ordering of values, called an *I Scale*, corresponds to the rank order of the absolute distances of the value stimulus points from the ideal point (the nearest being the most preferred). The analytical problem in constructing the social choice pattern is how to "unfold" these I Scales in such a way as to determine the J Scale. A detailed example of the procedures is given in Coombs (1964, pp. 96-102).

Cases which do not fit into the Coombs' model occur when: (i) individuals have intransitive preferences, (ii) individuals use some single attribute other than that defined by the test J Scale, (iii) individuals make judgmental errors (including indifferences), (iv) individuals are using several interacting attributes to rank the values, and (v) the items in the test are not mutually exclusive. If the majority of cases fit the J Scale model, the J Scale describes a social choice order acceptable to the majority of the population.

The possibilities for creating a social preference order for a given population rest on the assumption that a single common perception underlies the preference orderings, regardless of the amount of variance among individuals on the actual ranks. The probabilities of a single common J Scale occurring by chance in a population are very small.

Experience with applying unfolding analysis to experimental or survey data indicates that individuals employ several interacting selection criteria (perceptions) to choice problems much more frequently than they respond to a common perception, and, as the choice problem grows in complexity and the number of items to be considered increases, individuals will be more likely to use several interacting criteria to put their preferences in an order. The unfolding technique in one dimension is most useful for determining if a single perception is in use by the majority of the population, but cannot provide a means of aggregating multiple perceptions into a single social order. A survey of multidimensional techniques and studies of preferential choice data indicate that the best results such analytical techniques can produce are sets of solutions, i.e., sets of social orders, rather than a single solution.

In summary, the selection of measurement models used to collect and interpret information about preferential choices must be based on consideration of the following characteristics of human choice behavior.

(i) Rather than select among items on the basis of common perception, different individuals often make use of different criteria to generate a preference order among items.

(ii) The successive choices of individuals constructing an ordinal ranking of items may reflect an assumption that the first choice is achieved or satisfied. If the individual suspected that his first choice might not be satisfied, he might have specified an alternative order for the remaining items.

(iii) Individuals may be indifferent as to which order several items assume.

(iv) Individuals can be expected to make errors in judgment.

<u>The Preference Measurement Model and Development of a Least Disliked Social Order</u>

A key point in the collection and analysis of data lies in the selection of a measurement model. Measurement models must be selected which are consistent with assumptions made about preference formulation and are amenable to aggregation into a social order. The *measurement process* is the systematic assignment of numbers to a set of observations to reflect the status of each member of the set in terms of the property under investigation. A *scale* can be defined as a set of elements, each consisting of three components: (i) an observation or individual, (ii) a number, and (iii) a rule or set of rules linking the individual and the number. These rules are often called *mapping rules* because they serve to represent non-numeric properties of the individual in terms of numbers. The system of mapping rules constitutes the *measurement model*. The preference order among a set of items, the activity related to the items, and the desired use level for the items, each requires a different measurement model because each is a different expression.

Before selecting a measurement model for preference order, two characteristics of human choice must be considered. These are *judgment error* and *intransitivity*. In selecting among an array of alternatives, individuals occasionally choose alternatives which do not reflect their real preferences. Generally, these errors are caused by: (i) misperception, (ii) unwillingness to make choices on certain sets of alternatives, and (iii) indifference. In land use problems, we assume individuals are being confronted with both a novel set of alternatives (i.e., the average individual citizen does not normally experience, in his day-to-day living, the set of land uses presented to him by the resource manager as a set of interrelated alternatives), and a novel selection criterion (i.e., individual citizens are rarely required to make land use decisions for either a community or region). Because of the novelty, we may anticipate judgment error occurring with greater frequency than in a choice problem with which people have a great deal of practice.

Transitivity assumes that individuals are consistent in their preference ordering in the sense that if A is preferred over B and B over C, A is preferred over C. However, human thought processes are not always consistent; indifference, for example, is not generally assumed to be a transitive relationship (e.g., if an individual were adding pepper to soup, one grain at a time, he might be indifferent between the first and second grains, between the second and third grains, between the third and fourth grains, but still prefer the first to the fourth grain). Accordingly, a scale must be used which prevents an intransitive order from occurring.

Because an individual will probably use several interacting criteria to order a set of items, human preference must be assumed to be a non-monotonic function. If preferences of a population are not based on a monotonic measure, they cannot be reconciled with a monotonic scale (i.e., a single social order).

If, instead of attempting to fit individual non-monotonic data into a monotonic scale, we concern ourselves only with measuring a monotonic population property, we can easily develop a variety of social orders. Any time a set of data is scaled through some technique, such an order is produced.

Although the manager is faced with the problem that a single social order is usually not possible, it is still possible to select an order such that no other order would be preferred. Thus, the social order we wish to develop for the resource manager or for entry into a decision model, such as goal programming, has some special requirements. The procedure used to construct this order must: (i) weight all individuals equally, (ii) satisfy the preferences of the majority (51%) of the population, (iii) weight individual preference choices according to strength of preference, (iv) observe dependence of values in the individual orders, and (v) develop a social order from among a set of values containing several underlying perceptions on which the majority is indifferent.

The following procedure has been devised to satisfy these requirements. The preferential choices of the population are arrayed so that the set of items describes columns and order of preference describes rows. This is called a *preference measurement model*. The number in the cells represents the number of individuals who assigned a given item a given preference. The data array for a case study is illustrated in Fig. 1.

If one of the items receives a majority of first place "votes," as "grazing" does in the example, it is given first priority in the social order scale. If no item receives a majority of first place "votes," the item with the most last-place votes is eliminated, and is given the lowest value in the social order scale (shown by the example of "all-terrain vehicles" in Fig. 1). If an individual's choice cannot be satisfied because it conflicts with the preference orders of most members of the population, the procedure attempts to compensate him by granting him an additional vote in the next choice.

This process continues until one item acquires a majority of first-place votes; this item is eliminated from the set by assigning it the highest available value. The process begins again on the remaining set of items and continues until all the items are eliminated because they either receive a majority of "first-place votes" or "most disliked votes."

PRIORITY ORDER	GRAZING	CULTIVATION	OIL DRILLING	MINERAL EXPLORATION	NATURAL GAS EXPLORATION	HUNTING	CAMPGROUNDS	BIRD WATCHING	ROCK HUNTING	PUBLIC UTILITIES	ALL-TERRAIN VEHICLES
1st	46	0	0	0	0	0	0	0	0	0	0
2nd	0	6	16	4	0	3	0	12	3	2	0
3rd	0	0	9	9	9	0	1	3	10	5	0
4th	0	0	10	12	12	4	0	5	2	1	0
5th	0	1	3	3	12	2	5	4	6	10	0
6th	0	1	3	6	6	6	2	10	8	3	1
7th	0	1	3	5	2	6	6	7	9	7	0
8th	0	0	1	3	3	17	6	3	8	5	0
9th	0	11	0	2	1	3	17	2	0	6	4
10th	0	8	1	1	1	4	8	0	0	6	17
Last	0	18	0	1	1	1	1	0	0	1	24

GRAZING, ___, ___, ___, ___, ___, ___, ___, ___, ___, ALL-TERRAIN VEHICLES

1 2 3 4 5 6 7 8 9 10 11

Fig. 1. Preference measurement matrix: land management preference order.

This procedure clearly weights all individuals equally, weights individual preferences according to strength, prevents an intransitive order from occurring, and observes dependence among items within individual orders.

Survey Instrument for Preference Orders

The final step in developing measures of preferential choice is to construct a set of response categories for a preference order which: (i) defines the problem clearly and completely and in such a way that the subject has the same understanding of the type of information desired as the investigator; (ii) is simple for the subject to complete; (iii) encourages the subject to be as accurate, precise and complete as possible within the context of the problem; (iv) avoids value implications and investigator bias (items are occasionally constructed which give the subject clues to the response desired by the investigator or the subject's reference group); and (v) is in a form which minimizes the amount of coding necessary.

The preference measurement model requires that the data on preferences for each item be given ordinal scale assignments. To indicate preferential choices among a set of items, the investigator may ask a respondent either to pick some of the items or to rank order some or all of the items. The method of rank order will be used since it carries the maximum amount of information, prevents the subject from making an intransitive response, and is most cost efficient.

Measurement of preference can be obtained by use of several techniques. A procedure adaptable to small scale mail surveys is the gummed label technique. One page of the survey instrument carries a set of gummed labels printed with a short notation for each of the items. A rectangular box (one label wide and m labels long) is printed on the second page. The box is labeled "most preferred" at the top and "least preferred" at the bottom. The subject is instructed to remove the labels from the first page, one at a time, and to place them in his desired order within the box. In coding the answers for data analysis, the items are treated as variables and assigned numbers to indicate priority ranking.

For individual interview techniques, a card and slot technique is useful. In this procedure each item is described briefly on a card. The cards are then placed in order in slots according to the preference order of the respondents. This procedure has the advantage that the respondent can rearrange the order, but clearly is not suitable for mail surveys.

For large scale mail surveys, a procedure which greatly reduces or eliminates hand coding is desirable. In these cases use of forms which can be tallied with an optical mark reader achieves these needs (see Appendix A for example).

PREFERENCE LEVELS

We have assumed that preferences among a set of items are formed on the basis of their similarity to an ideal alternative. Research in several fields indicates that the process of identifying a desired use level for an item is a much more complex process. In addition to relative desire for the item, individuals are known to be influenced by a set of subjective expected utility factors. These are: (i) the expected probability of the item being obtained, (ii) the amount of uncertainty about the attainment of the item, (iii) the amount of background information available, (iv) the desire to conform to perceived social opinion, and (v) the cost of obtaining the item under various circumstances.

The most important influences are amount of available background information and expected probability of attainment. If a person is unfamiliar with essential elements of the problem (i.e., unfamiliar with present levels of consumption, potential limits to consumption, renewability rates of the resource, and costs attached to raising or lowering the use levels), he will have great difficulty in selecting a use level. If he perceives the item to be trivial, he will have greater difficulty selecting a use level than if he considers the item to be important. If he perceives the item to be controversial, he will select use levels appropriate to his stand on the issue.

Individuals also seem to adjust their aspirations to the attainable. What is perceived to be attainable is chiefly a function of past experience (expected probability), variable cost of attainment, and relative uncertainty.

Because of the problems in determining achievement levels for each preference item, we do not recommend determining use levels from a general survey procedure. Rather, we recommend that levels be determined by a subset of the population, especially including knowledgeable professionals and informed citizens in the area most relevant to the preference item.

On the other hand, we recommend that the preference order be determined from a broadly based, statistically reliable survey procedure. By utilizing both a survey procedure for preference orders and interviews with knowledgeable individuals to determine levels, both information utilization and legitimacy can be achieved.

Most quantitative planning procedures require that information about preference levels be in the form of interval or ratio scale assignments and that the scale assignments be in the form of common measurement units wherever possible. We assume that the psychological process of forming aspiration levels occurs in a fashion similar to that of forming preference orders; i.e., the subject assigns aspiration levels to items which reflect his relative preference for them as modified by subjective expected utility factors. If the subject were using a single unit of measurement in forming aspiration levels, he would in effect be assigning each item a percentage of the total number of units available in the planning area. Accordingly, the response item category which best reflects the psychological process is one which asks the subject to state his desired use level for each land use in the form of a ratio scale. The ratio scale model is very useful for mutually exclusive uses, but is not necessary for multiple use goals. The ratio information can be most easily converted to interval scale equivalents by the investigator in the coding process since a high incidence of error would result from having each subject perform these calculations during the data collection process.

Measurement of preference levels can be obtained by dividing the items into single-use and multiple-use sets and by asking the subject to state either output units or percentage of land area to be assigned to each item listed. In the interview schedule formats, the output units should be listed on a separate page from the land area percentage and should be accompanied by spaces for writing in responses. In mail surveys, it may be desirable to determine land area percentage and demand, but it generally is not useful to ask for output units (such as timber volume to be harvested) in such surveys.

FURTHER ANALYSES

Other analyses are necessary to determine other aspects of the goal identification process. These include:

(i) a method for determining the general level of agreement or disagreement in a population,

(ii) a method for determining which of many possible levels of achievement to state for each item,

(iii) a method for determining which preference orderings are related to various social groups,

(iv) a method for determining the agreement of administrative structure and active interest groups with general public expectations, and

(v) a method for identifying individuals who are most likely to represent various viewpoints in successive iterations of the management planning procedure.

For question (i) we use Kendall's concordance coefficient and for question (ii) a histogram of all responses for each item is developed (see computer routines KENDAL and LEVEL, respectively). For questions (iii), (iv) and (v) we have developed some modifications of factor analysis which are discussed at greater length in the next section.

STATISTICAL ANALYSES

KENDALL'S CONCORDANCE COEFFICIENT

Given a set of observations each containing ordinally ranked data, such as a set of responses from several individuals consisting of their priority rankings of preference items, it is of interest to determine the degree to which there is agreement or lack of agreement among the observations (the individual's responses).

A statistical procedure developed by Kendall calculates a single number, called Kendall's concordance coefficient, which indicates the level of agreement (concordance) in the data. This coefficient, usually denoted by W, is calculated by the formula

$$W = \frac{12}{k^2\ (N^3-N)}\ \Sigma\ (R_j - \frac{\Sigma\ R_j}{N})^2 \qquad (1)$$

where k is the number of observations, N is the number of items being ranked and R_j is the sum of the rankings of the jth item.

The result of this calculation is always a number between 0 and 1 with values of W close to 1 representing a high level of concordance and values of W close to 0, a low level of concordance.

In cases where the number of items being ranked is greater than seven (N>7), an additional test may be performed to determine the significance of Kendall's concordance coefficient. Called the "chi-square test," it determines whether the degree of concordance indicated by W exceeds what we might expect to occur simply by chance. χ^2 is calculated by

$$\chi^2 = k(N-1)W \qquad (2)$$

and is compared with a table of the χ^2 values one could expect if there were only a chance correspondence among the rankings. The table values are called "χ^2 values for N-1 degrees of freedom at the .05 level of significance." If the χ^2 which is calculated by Eq. 2 exceeds the value in the table, then this means that we may be 95% certain that the level of agreement among all the observations is higher than it would be by chance.

FACTOR ANALYSIS

Scientists are frequently presented with a set of data representing scores or measures of the behavior of individuals with respect to each of several items or variables. For example, a psychologist may deal with the responses of a set of individuals to various test items on an intelligence test, or a political scientist may wish to analyze something as complex as the behavior of a set of nations with respect to such attributes as power, trade, and energy consumption. Given such data, the scientist seeks rules to explain his observations by means of certain unifying attributes which, in some sense, simplify the data. Especially helpful in those areas where scientific laws are unknown, and where even hypotheses are few, is the statistical technique known as *factor analysis*. Given a set of data of the type described above, factor analysis provides a method for determining a set of underlying attributes or *factors* which can explain the intercorrelations among the variables. The general goal of factor analysis is the reduction of the number of variables to a smaller set of variables called factors with which the original data has a high degree of correlation.

In certain cases, each of the variables in the new (reduced) set is identified by a new name (such as "trade" and "energy consumption") which can be taken as having some theoretical significance. However, this is not always done, nor is it necessary. Frequently each new variable or factor may be identified simply as a combination of several of the old (more numerous) variables, for purposes of providing a better perspective on the available data. Using factor analysis to isolate factors of this type can be of great benefit for analyzing data in a visual or graphical format.

The procedures involved in factor analysis generally follow these major steps as outlined by Comrey (1973): (i) selecting the variables; (ii) computing the matrix of correlation coefficients among the variables; (iii) extracting the unrotated factors; (iv) rotating the factors; and (v) interpreting the rotated factor matrix.

Selecting the variables from which the factors are to be extracted rarely presents a problem, since the nature of the existing data usually dictates what the variables will be. Ordinarily these are the individual test or response items, although in some cases they may be condensed into sets such as sub-tests. In general, the variables are taken to be those items to which each individual has responded and thus have been assigned a numerical value or score. In our usage, the variables are defined as preference items for alternative land uses, while the scores are the rankings given these items by the responding individuals.

Once the variables have been selected, the next task of the investigator is to determine the correlations that exist between pairs of variables. The responses to each item are compared to the responses to each other item, and each pair of items thus compared is assigned a number (called Pearson's product-moment coefficient) between -1 and +1 indicating the degree of similarity between the responses. Coefficients close to +1 represent a strong positive correlation or degree of agreement among responses, coefficients close to -1 represent a strong negative correlation or opposite responses, while coefficients near zero indicate little apparent relation between responses to the two items of the pair.

The equation used to calculate the correlation coefficient (r_{ij}) between variable i and variable j is:

$$r_{ij} = \frac{\Sigma xy}{\sqrt{(\Sigma x^2)\ (\Sigma y^2)}} \tag{3}$$

where the sums are taken over all the observations or individuals' scores on variables i and j, and where each x is the departure from the mean of variable i and each y is the departure from the mean of variable j.

Once all the coefficients have been calculated, they are entered into a matrix R with rows and columns identified by the variables:

$$\begin{array}{ccccccc} \text{Item} & & 1 & 2 & 3 & & m \\ & 1 & r_{11} & r_{12} & r_{13} & \cdots & r_{1m} \\ & 2 & r_{21} & r_{22} & r_{23} & \cdots & r_{2m} \\ R = & 3 & r_{31} & r_{32} & r_{33} & \cdots & r_{3m} \\ & \vdots & \vdots & \vdots & \vdots & & \vdots \\ & m & r_{m1} & r_{m2} & r_{m3} & \cdots & r_{mm} \end{array} \tag{4}$$

Observe that the matrix is symmetric, i.e., has the same numbers above and below the indicated diagonal. This is because r_{ij}, the correlation coefficient for items i and j, is the same as r_{ji}. The diagonal entries (r_{ii}) are ordinarily set equal to one, depending on the method being used to extract the factors.

The next task is to isolate the factors using the matrix R. In general, one needs to determine in advance how many factors are to be extracted. Often considered one of the most difficult aspects of factor analysis, fixing the number of factors can in certain cases be simplified by reference to previously completed analyses of similar data. In case the number of factors extracted is two, graphical representation becomes a viable possibility, since each factor may be expressed as an axis in a two-dimensional space. The principle involved in extracting factors is to find those hypothetical variables which can account for as much of the correlation among the original variables as possible. For each factor that is extracted, a column of numbers is calculated which represents the correlation of each variable with that factor. These numbers are called the "loadings" of the variables on that factor. After the first factor is extracted, the effect of this factor is removed from the matrix of correlations R, and a new matrix representing the "residual" correlations is computed. A second factor may then be extracted if the residual correlations are sufficiently substantial to warrant doing so, and so on, until the residual correlations are too small to continue.

If the columns of factor loadings for all the factors thus extracted are put together in a matrix (usually called "A"), it happens that, mathematically, the matrices R and A have the following relationship:

$$A\,A' = R \tag{5}$$

where A′ represents the transpose of the matrix A. From a mathematical point of view, then, the task of extracting factors reduces to the task of decomposing the matrix R in such a way that it can be expressed as the product of a matrix and its transpose.

The fact that R is a symmetric matrix brings into play some basic theorems of linear algebra which make such a decomposition possible. Omitting the mathematical details (see for example Comrey, 1973), it turns out that the required matrix A can be calculated as:

$$A = B'\sqrt{D} \tag{6}$$

where D is the diagonal matrix of eigenvalues of R, and B′ is the transpose of the matrix B of normalized eigenvectors belonging to those eigenvalues. These may be calculated by standard procedures such as the diagonalization method of Jacobi used here.

The eigenvalues of matrix R are those values λ_i for which there exist vectors $\underline{b}_i$ such that the multiplication of that vector by the matrix returns the vector $\underline{b}_i$ multiplied by a constant (λ_i), i.e., for which:

$$R\,\underline{b}_i = \lambda_i\,\underline{b}_i \tag{7}$$

The vector $\underline{b}_i$ is called the "eigenvector belonging to the eigenvalue λ_i." All the eigenvalues of the matrix R will appear on the diagonal when the matrix is transformed into diagonal form D.

The matrix D is of additional interest, since its entries provide needed information about the factors. Specifically if

$$D = \begin{bmatrix} \lambda_1 & & & & \\ & \lambda_2 & & & \\ & & \cdot & & \\ & & & \cdot & \\ & & & & \cdot \\ & & & & & \lambda_m \end{bmatrix} \tag{8}$$

the proportion of the variance extracted by factor i is given by

$$\frac{\lambda_i}{\sum_{j=1}^{m} \lambda_j}, \tag{9}$$

the proportion of each eigenvalue relative to the total.

In a completely random data set each factor will account for 1/m of the total eigenvalues, where m is the number of variables. Thus in a data set containing nine variables, each factor will account for 0.111 of the total variance.

If a list of rankings is used as input data, the rank of the mth item to be ranked is completely determined by the ranks of the previously ranked m-1 items; in this case only m-1 factors account for all the variance, and the proportion of variance accounted for by each factor is 1/(m-1). Thus, in a data set of nine variables, each of the eight factors of non-zero variance will account for 0.125 of the total variance.

Since no data set is completely random, however, these theoretical values are never exactly achieved. For example, with a "random" data set of 2400 observations with nine ranked variables, the first factor accounted for 0.135 of the total eigenvalues, and the eighth factor accounted for 0.115 of the total eigenvalues.

Since the proportion of eigenvalue totals can thus be calculated for a random sample, it is instructive to compare the eigenvalues of an actual sample to the calculated values of random samples. Those factors with greater than a random value can be considered important in an interpretation; those with less than or equal to a random value should not be considered in interpretation.

We have found in several detailed survey results that ranked values for variables can usually be expressed with only two factors. The third factor is usually very near a random value, and the fourth and higher factors account for less variance than expected for a random effect (Fig. 2). Thus, for data of this kind, we recommend that two factors from the factor analysis be exhibited.

Once these calculations have been completed, and the matrix of factor loadings A has been found, the factors can be identified by the columns of A. A is called the unrotated factor matrix, and each column represents a factor, with the entries in the columns signifying the loadings for each variable. Note that the sum of the squares of the loadings of factor i (entries in column i) yields the eigenvalue λ_i. In addition, the sum of the squares of the row entries have statistical significance. These numbers, called the *communalities* represent the extent of the overlap between each variable and all the factors. Thus a communality near to a value of 1 for a particular variable indicates that variable overlaps almost completely with the factors in what it measures.

The factor analysis does not stop here, however. Because the procedure thus far has been designed so that each successive factor extracts as much of the variance as possible, the resulting factors tend to be combinations of large numbers of the original variables, and are rarely useful. For this reason, a further procedure is initiated, called the *rotation* of the factor matrix. The objective of the rotation is to determine a new set of factors called the *rotated factors*, each of which correlates with a smaller number of the original variables. The rotated factor matrix is equivalent mathematically to the unrotated factor matrix, however, and the communalities for each variable are unchanged. The rotated factors (columns) differ from the unrotated factors in the distribution of the loadings, since each of the rotated factors should have high loadings for a small number of variables.

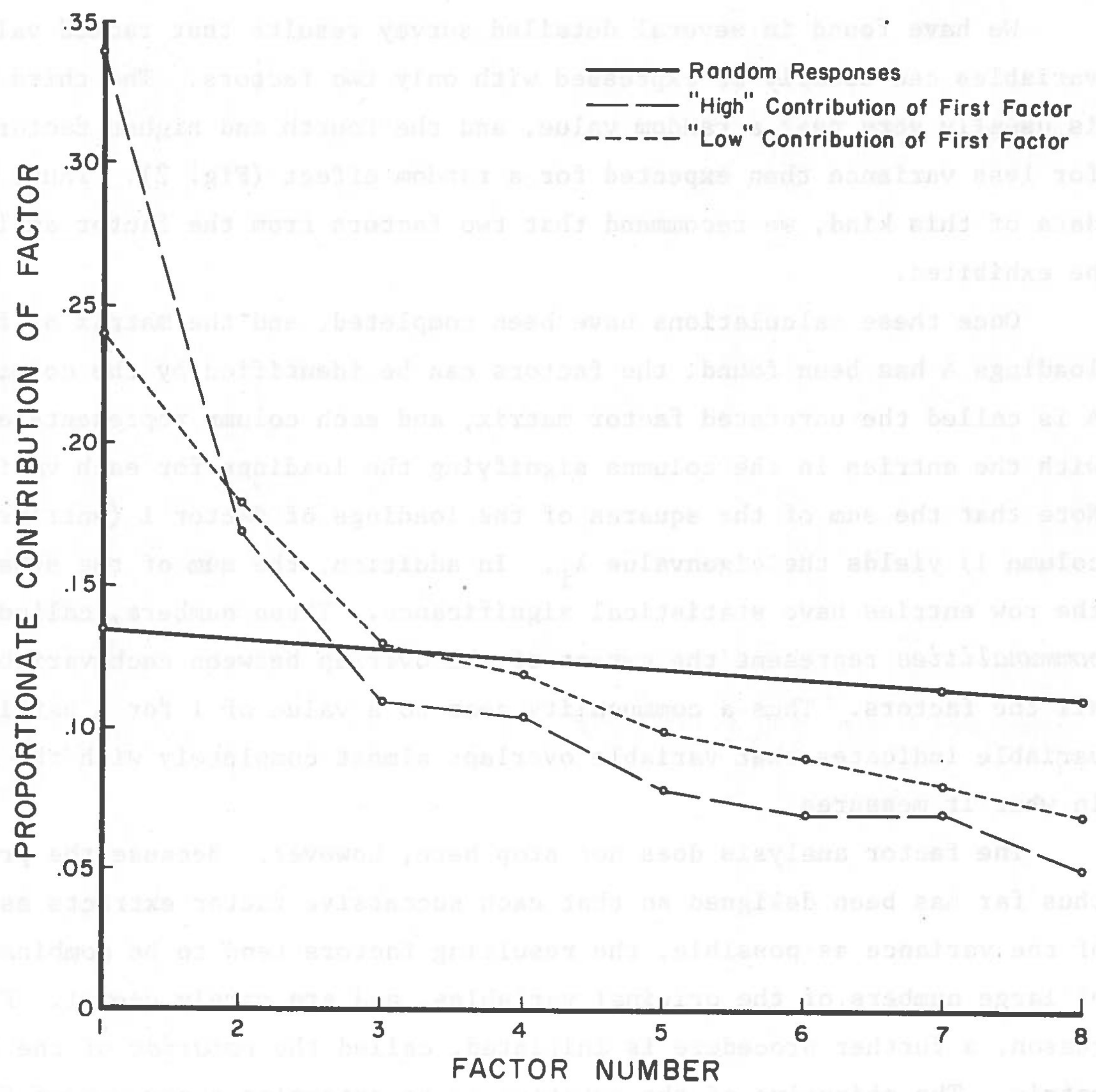


Fig. 2. Comparison of eigenvalues determined by factor analysis of random samples and actual survey data.

There are several methods available for effecting the rotation of the factors, the most frequently used being Kaiser's Varimax method which results in an orthogonal solution with maximum variance. Where two factors are rotated, this means they may be represented by axes which are perpendicular.

Because certain approximations are introduced in the process of rotating the factors, it is often considered useful to provide a check on the equivalence of the rotated factor matrix with the unrotated factor matrix. This can be done by determining whether any significant changes have occurred in the communalities, which are theoretically equal for both matrices. Thus a *check on communalities* may be made by calculating both sets of values (the sums of the squares of the row entries), and computing their differences.

The final step in factor analysis involves interpreting the rotated factor matrix. This may be done in several ways, but in the case where only two factors are extracted, an interpretation can be obtained by visual geometrical representation, since only two dimensions are involved. In this case, each factor may be considered as an axis, and when the Varimax procedure is used, the two axes are perpendicular. The two-dimensional space defined by these axes is called the *factor space*, and provides an orientation for graphical representation of the data. The axes are scaled in such a way that the origin (0.0) represents the mean value of each factor (zero), and the units into which the axes are divided represent standard deviations (positive and negative) from the mean.

Several kinds of information may be plotted onto the factor space. Of initial interest is the relationship between the original variables and the extracted factors. Here the variables are located on the plane by coordinates equal to the factor loadings. That is, the first coordinate for each variable designates the correlation between that variable and factor 1 (and is equal to the loading of that variable on factor 1), while the second coordinate designates the correlation between the variable and factor 2 (the loading on factor 2). In this way, each of the original variables is assigned a point in the factor space.

Original data observations can also be plotted, by means of their *factor scores*. These scores represent translations of the individuals' scores (in our example, rankings) on the original variables into scores on the factors.

Factor scores are calculated by means of *factor multipliers* derived from the factor loadings and represent the departure of the observation from the mean position (zero) in terms of standard deviations. Since the distribution along each axis is statistically normal, there will theoretically be more observations near the 0.0 point than at the extremes of either axis.

Theoretically we would expect that several data points would occur between 3 and 4 standard deviations from 0.0 in a very large data set. Empirically, however, we find that ranked data usually limits the actual departures to $\pm$ 2.5 standard deviations (Fig. 3). Using the calculated factor scores, each individual may be assigned a point in the factor space indicating his position with respect to the factors, with the arrangement of these points providing information on configurations of interests.

Additional data too, though they may not have entered into the initial factor analysis, may be overlaid onto the factor space. As scores (rankings) from more individuals become available, these may also be converted to factor scores, and the results plotted against the factor axes. This information can be extremely useful when compared to the distribution of points of the initial group of individuals.

Sample Data from Surveys

When mail surveys are used to collect data, it can be expected that many questionnaires will not be returned for tabulation. This poses an important question; who has returned and who has not returned the questionnaires? To look at this question, 2400 questionnaires were sent to a "random" sample of residents using telephone books to identify the address for each questionnaire. The sample was drawn from the residents living near six National Forest Ranger Districts. Of all the questionnaires sent, 823 were completed in sufficient detail to use in analysis.

The 823 questionnaires were then compared to a "random" sample of 2400 observations generated by a computer. The "random" sample, representing all the questionnaires mailed, is compared to the actual returns in Fig. 4. The most noticeable aspect of this figure is that the central point of the normal distribution is greatly under-represented in the returned questionnaires.

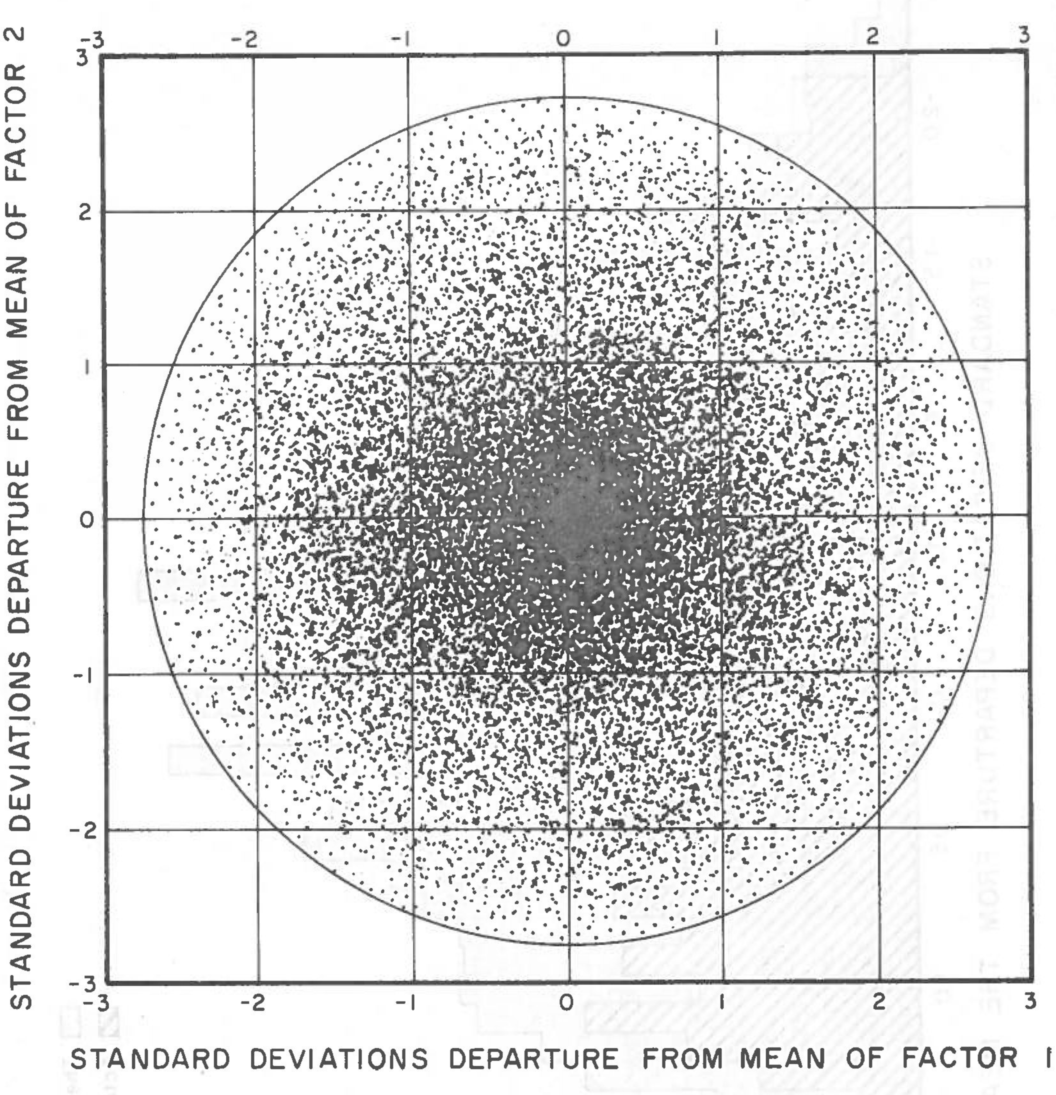


Fig. 3. Density diagram of individual observations plotted against factor axes.

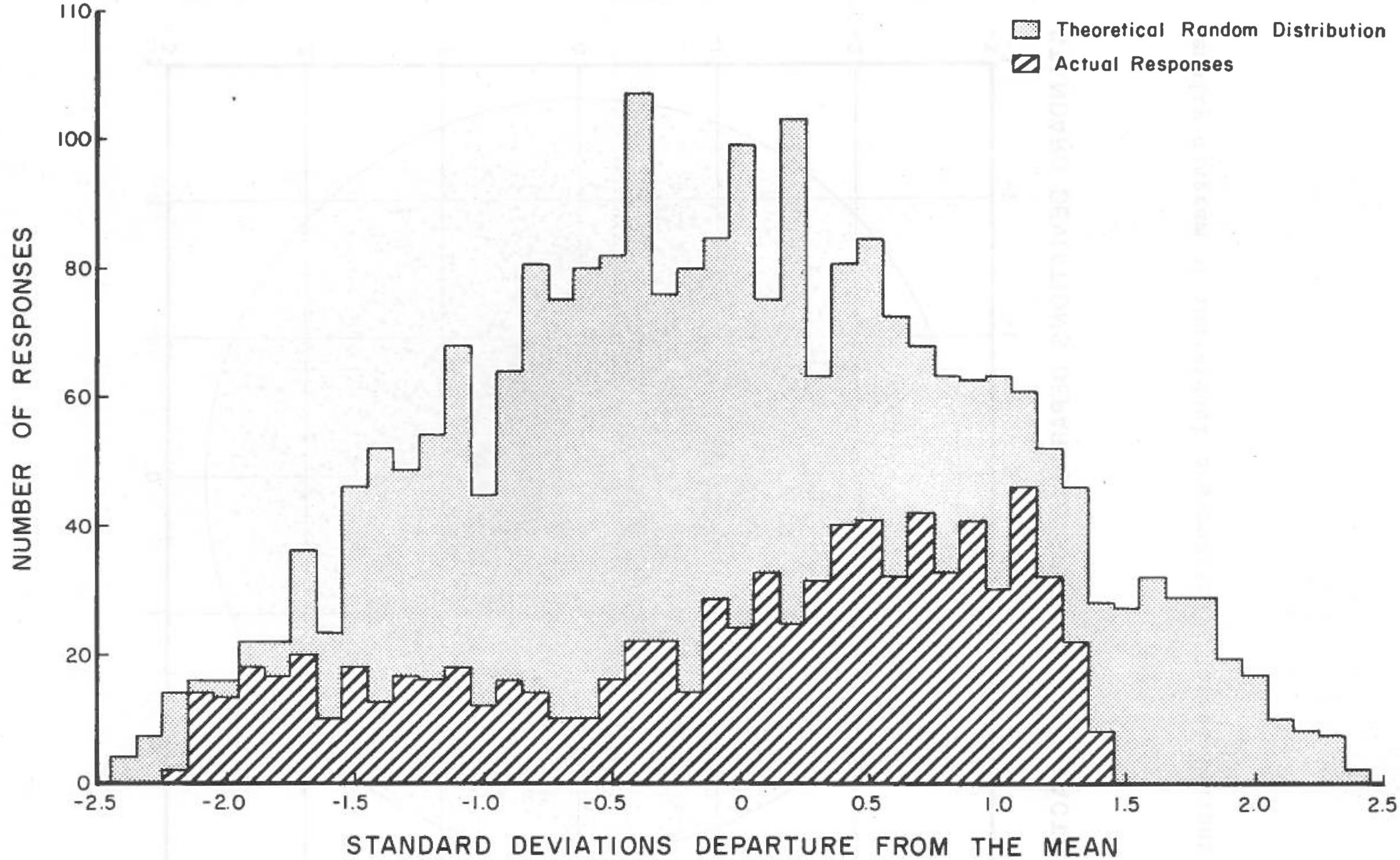


Fig. 4. Comparison of theoretical responses for ranked preference of nine items from a random population and actual responses from the population.

This is to be expected, however, since this represents a "middle-of-the-road" area where the interest levels of the individuals are so low that most did not bother to respond to the questionnaire. In addition, one of the most extreme positions seems to be shifted to a somewhat less extreme position at about +2.0 standard deviation from the mean; the other extreme position had values near the 2.5 standard deviation point.

The questionnaires used to collect these data listed nine types of uses common to the six districts. These were (i) wilderness, (ii) timber, (iii) minerals, (iv) watershed, (v) developed recreation, (vi) dispersed recreation, (vii) scenic beauty, (viii) wildlife, and (ix) range management. Respondents were asked to rank these uses from 1 to 9 according to their own priorities. Secondly, respondents were asked to rank the activities from 1 to 9 according to what they felt was the policy of the Forest Service.

In addition to the questions asked of the public, a similar procedure was followed with the staffs of the six districts. Some 227 of these questionnaires were filled out; in this case respondents were asked only to rank their own priorities.

The public's own opinion was considered to be the base data on which the factor analysis was performed, and the agency staff's view and the public perception of the agency were compared to this base. Based on the contribution of each factor (Fig. 2), the most satisfactory representation is a two-dimensional plot.

Each factor can be interpreted in terms of a combination of original variables (Fig. 5). The first factor is identified with dispersed recreation and scenic beauty vs. timber, while the second factor represents developed recreation vs. wildlife. The remaining original variables are identified with combinations of these two factors. Range management and watershed are negatively correlated with both factors. Minerals has a negative correlation with the factor of dispersed recreation and scenic beauty but a positive correlation with developed recreation, and wilderness is correlated positively with dispersed recreation and scenic beauty but negatively with developed recreation.

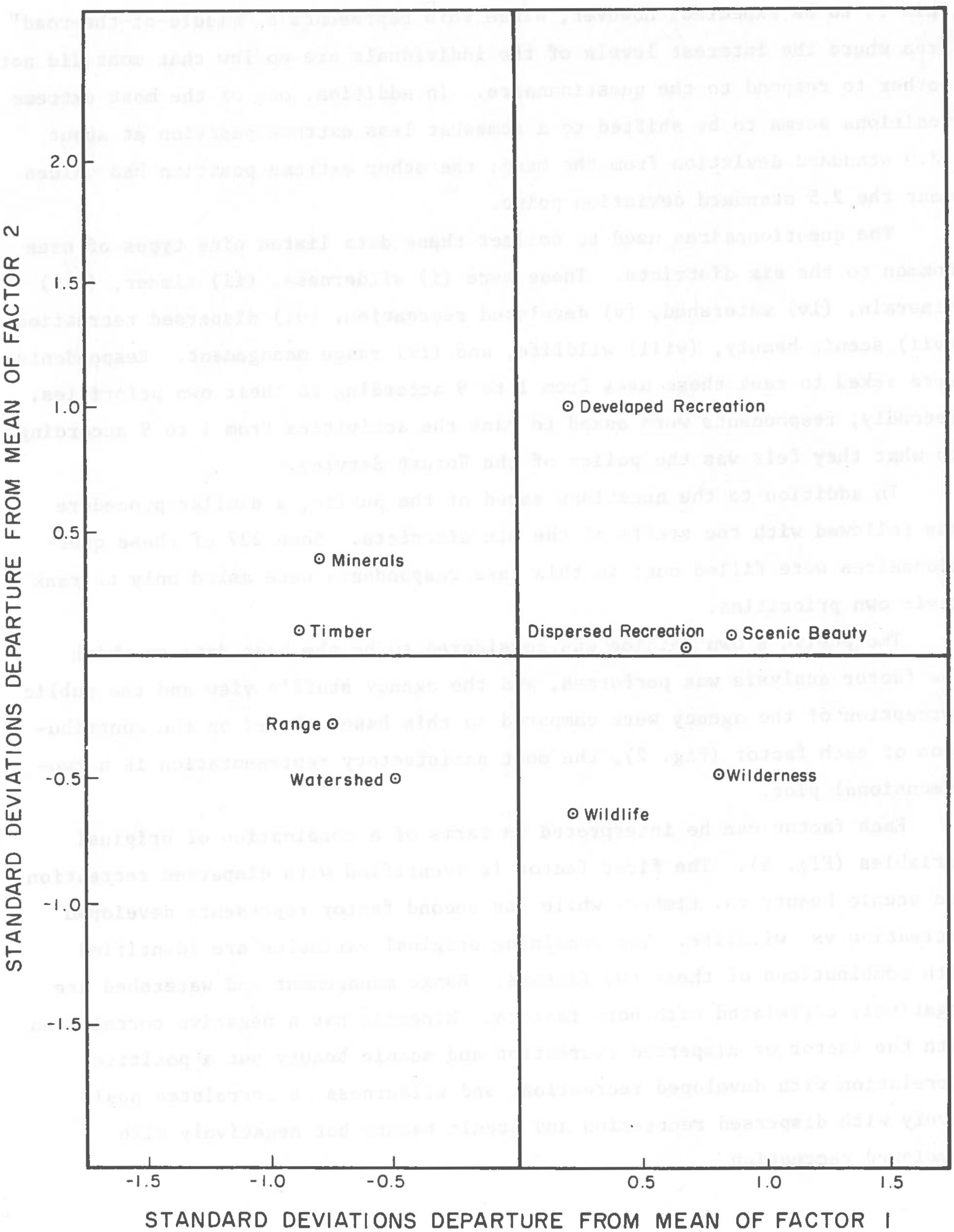


Fig. 5. Factor plot of nine variables used in the survey of public opinion of public land management. The variables in this configuration are used in defining each of the two axes of Fig. 6.

The location of each observation is calculated by using multipliers for each variable so that a score is calculated with reference to each axis. This score is the number of standard deviations which an observation departs from the zero points on the axes, thus scores may be either positive or negative (Fig. 6).

These same multipliers were also used for other data. We calculated the factor scores of the 227 agency staff personnel based on the multipliers from the public data. The result is an overlay of staff opinions plotted on axes which are determined by public opinions (Fig. 7). We also plotted the public perception of the agency's priorities against the public's own priorities (Fig. 8).

The plot of agency personnel shows how the attitude of the two groups compare. It is obvious from Fig. 7 that the opinions within the agency staff are essentially the same as the range of opinions in the public responses. If this is so, why should there be conflict between the public and agency personnel?

Part of the answer lies in Fig. 8 which shows that the public view of the agency priorities for each of the six districts departs somewhat from the public's own priorities. Thus, each district has a peculiar set of problems; the public perception of how the agency is treating these problems and the agency personnel opinions all vary. In some districts the difference between public perception of agency position and average opinion of agency personnel is small, in other districts it is large.

This appears to be a possibility for evaluation of information and education (I and E) programs. The degree of departure of public perception from the real agency position indicates a lack of communication; an effective I and E program will result in little departure since the public will clearly understand the agency position, an ineffective I and E program will result in larger departures. In our example, District 5 appears to have the most effective I and E program, and District 3 the least effective.

Another part of the answer lies in the position of the manager decision-maker (Fig. 8). The six decision-makers of the six districts are shown to have viewpoints widely divergent from the average of the public opinion; since these are key individuals in making management decisions their opinions may enhance the apparent conflict between the public and the agency.

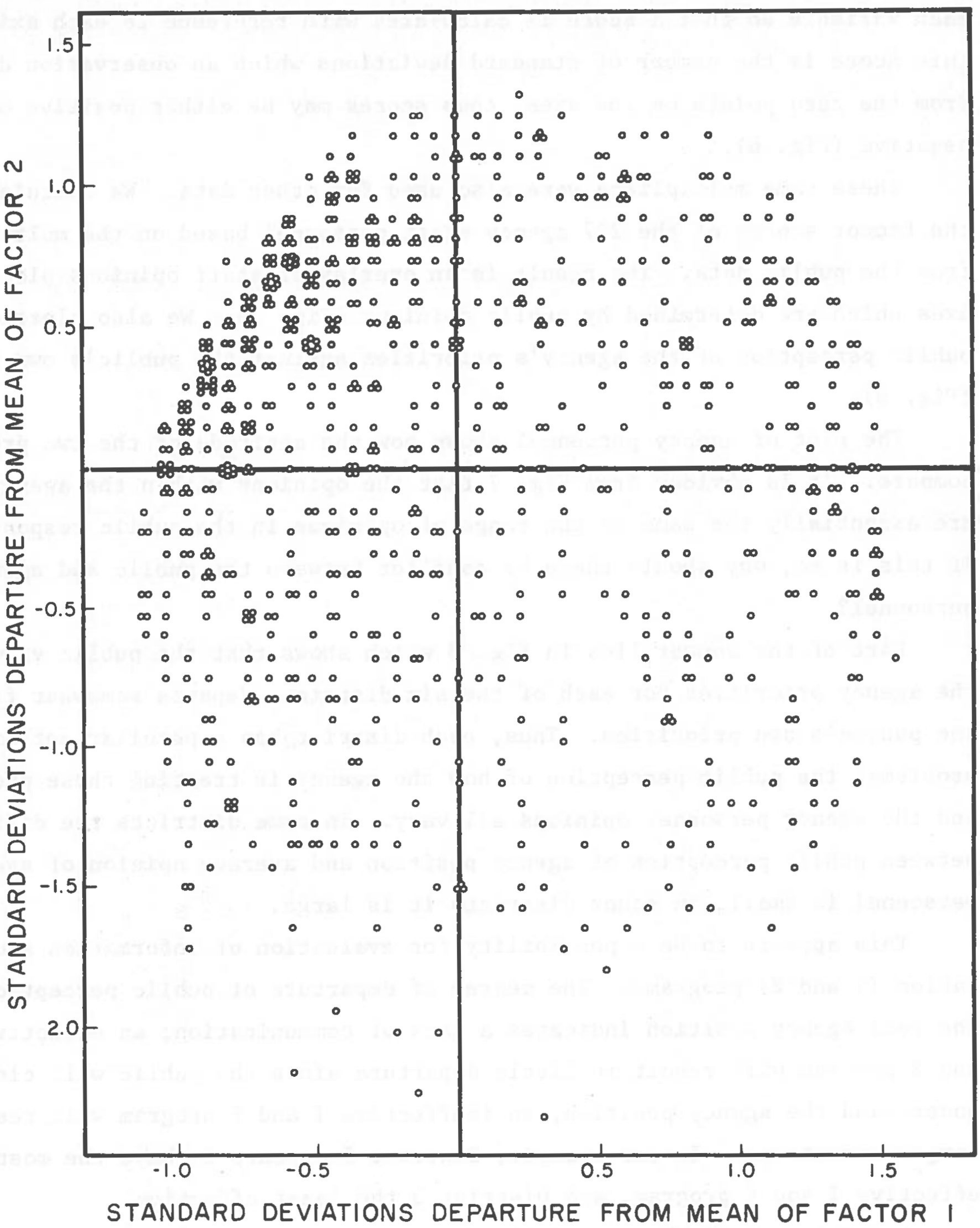


Fig. 6. Factor score plot of 823 individuals responding to a survey on priorities of public land management. Each axis represents a component of the data set, and observations are plotted according to the number of standard deviations from the intersection of the axes.

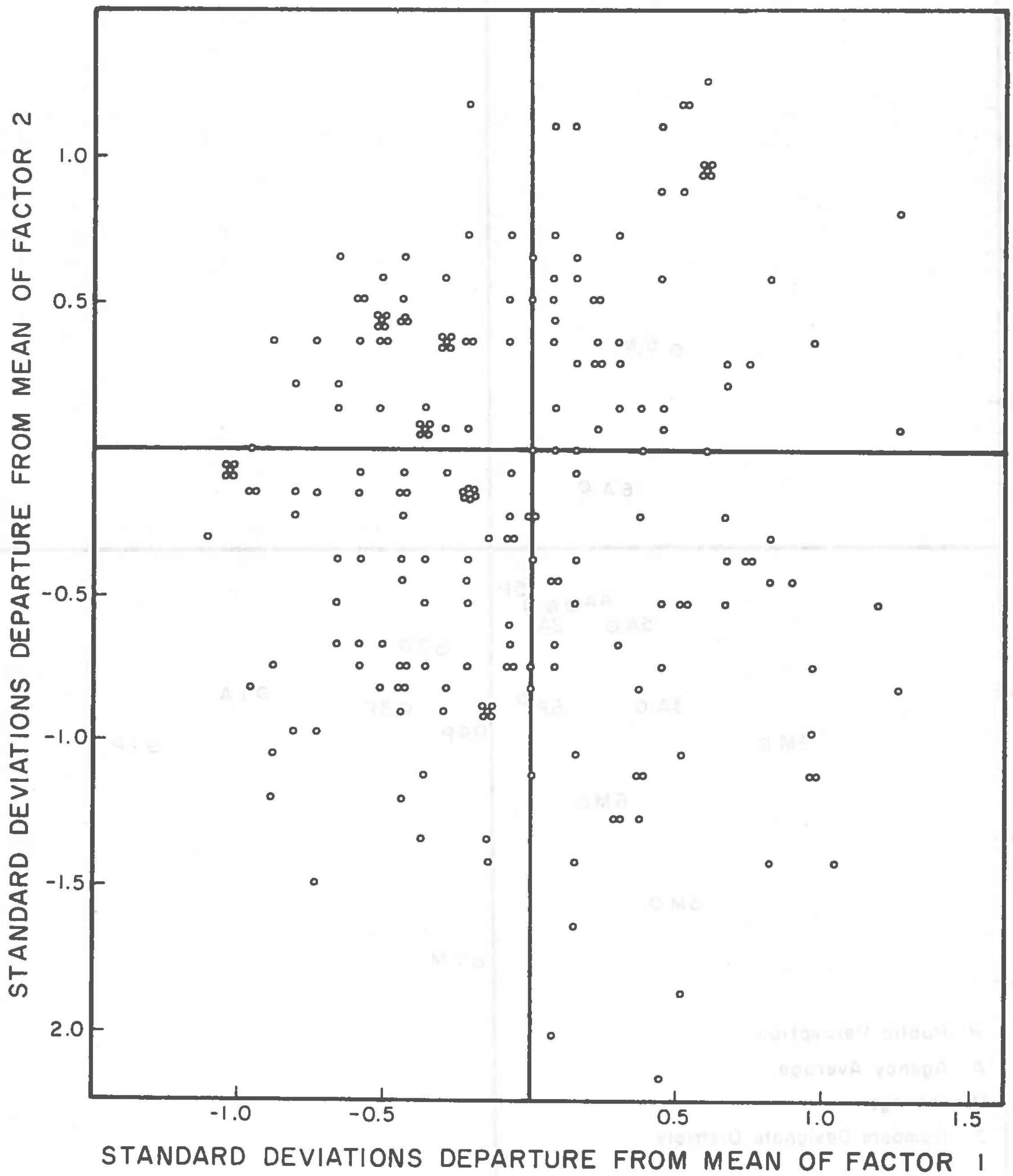


Fig. 7. Factor score plot of opinions of 227 agency personnel plotted against the public opinion axes of Figs. 5 and 6.

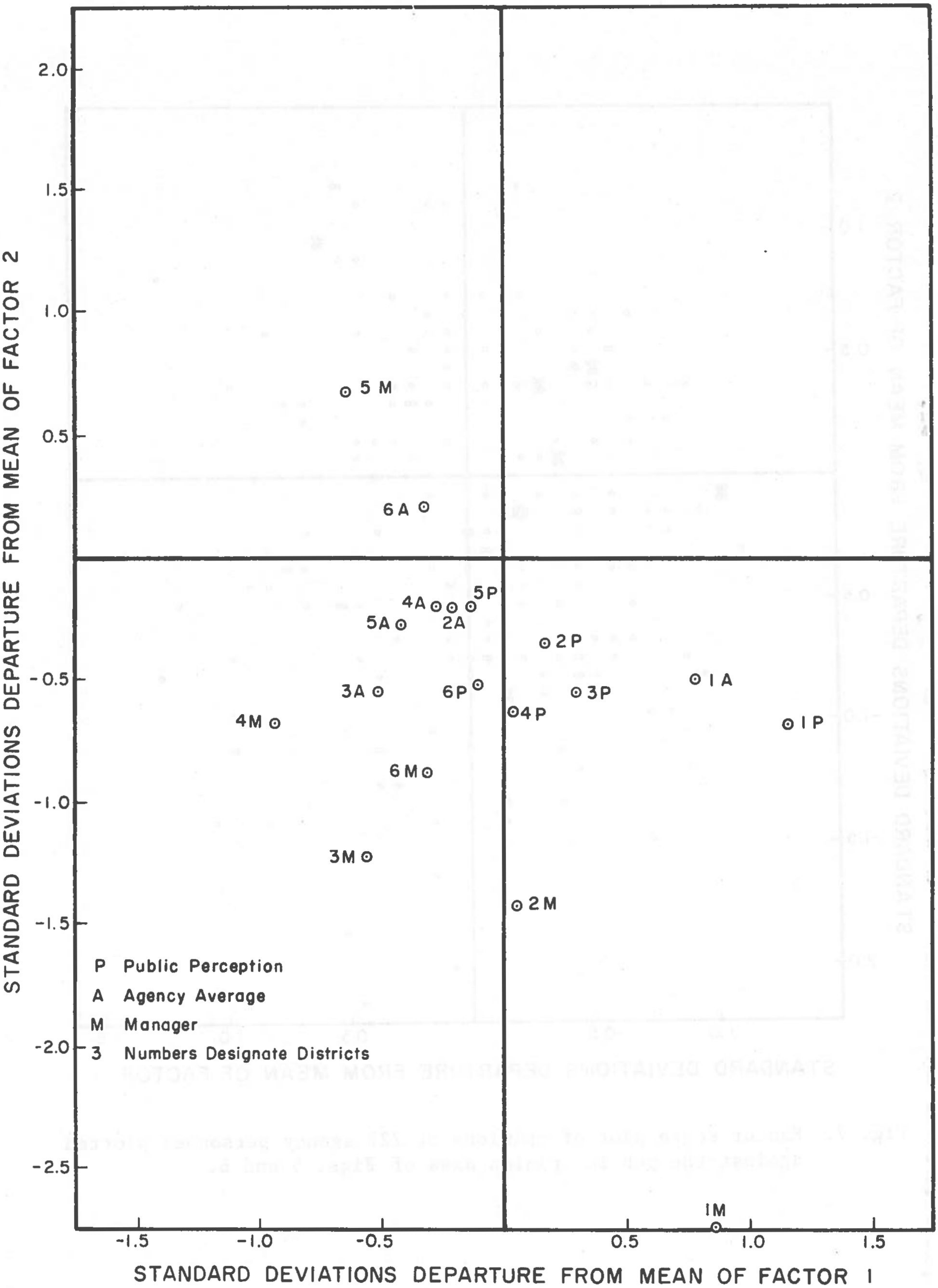


Fig. 8. Factor score plot of the public perceptions of agency priorities of six districts, average agency staff opinions, and the manager decision-maker opinions of these districts plotted against the public opinion axes of Figs. 5 and 6.

Armed with the information on configurations of interests derived from the factor analytic procedure, the decision-maker can thus identify potential areas of conflict that may develop if a particular management strategy is implemented. This knowledge, in conjunction with that gained from the preference measurement model, can serve to indicate what steps need to be taken in the iterative process of compromise to insure general public acceptance of management activities.

COMPUTER PROGRAMS

The measurement models as discussed in the previous section have been incorporated into a series of computer programs which are packaged into a main program called PUBLIC. This package provides the manager with two basic types of services: (i) analysis of multivariate data such as community interest and activity structures, and (ii) analysis of univariate data with common statistical procedures.

This package is designed primarily for batch input of data, but width of output tables has been designed to be suitable for remote interactive terminals. PUBLIC is designed to accept particular kinds of data and to perform particular analyses to assist with natural resource decisions and the study of public constituencies. It is not designed to be an all-purpose social science computer package; for more general uses the reader is referred to packages such as Statistical Package for the Social Sciences (SPSS), UCLA Biomedical Division Statistical Routines (BMD), or IBM's Scientific Subroutine Package (SSP).

OVERVIEW OF PUBLIC

The PUBLIC package consists of several subsystems (Fig. 9). The first is a sample identification program RANSAM which selects random samples from a standard telephone book (Appendix B). Once the data are collected, they are analyzed by the analytical routines of the main PUBLIC package.

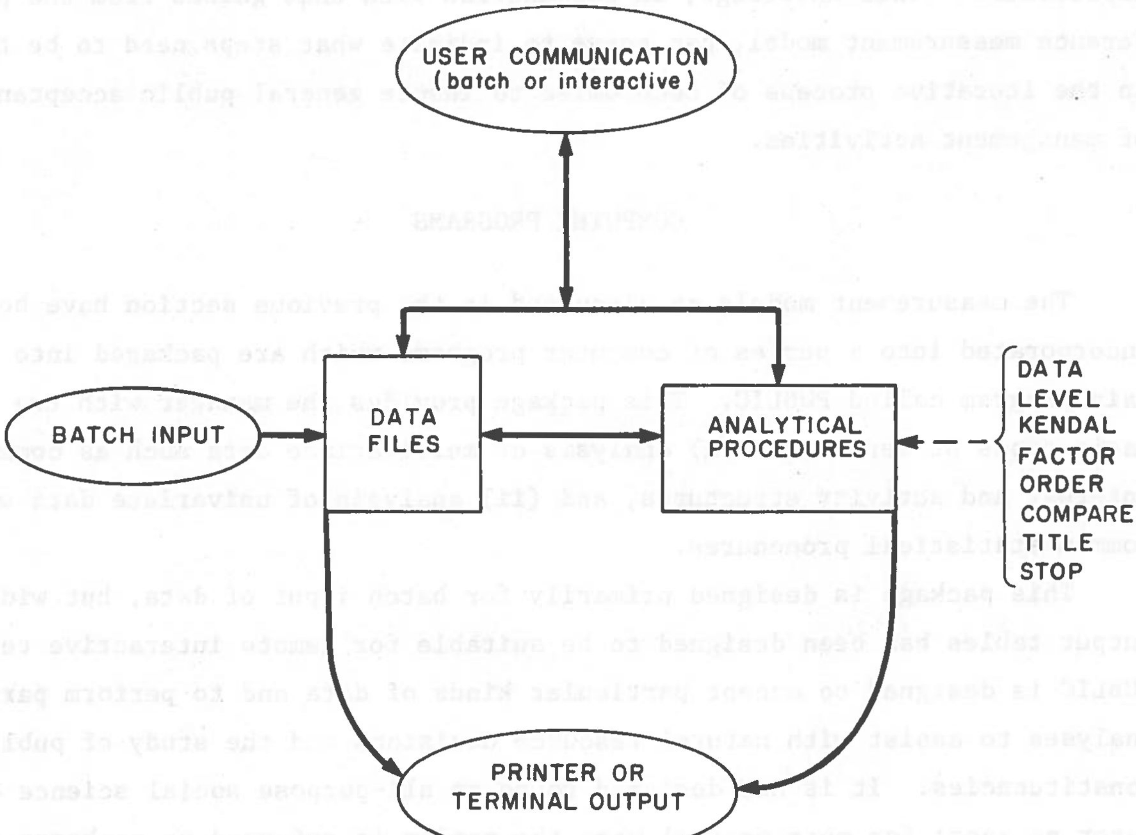


Fig. 9. A general overview of PUBLIC.

Survey data (usually gathered from precoded questionnaires) are arranged so that all data for an observation are entered in a block. As many blocks are entered as there are observations. The data block contains subscripted variables which correspond to questionnaire items. A header block in the data file indicates the number of identifiers and number of data items included in the file.

To initiate a task in the PUBLIC system the user calls up the program, and invokes any process by entering the name of the desired analysis. The command words are as follows:

TITLE	Read a new title card. This may be done initially or between any analyses.
DATA	Read data from a specified input device (if not specified, card reader assumed).
LEVEL	Descriptive statistics of a single variable.
KENDAL	Computes Kendall's concordance coefficient on specified variables.
ORDER	Computes least-disliked social order.
FACTOR	Computes rotated factor matrix and factor scores and plots factor scores. KENDAL and ORDER analyses are performed on subgroups identified by FACTOR.
COMPARE	Compares another data set to the factor matrix developed by FACTOR. Must be preceded by a FACTOR command.
STOP	Ends analyses.

The data routine reads in the data file according to the input format statement and writes onto temporary logical units; from the data files variables are selected for further analysis. If the values contained in a particular block of variables are invalid, the variable block will not be used for a particular analysis. Details of each command are described in the section Data Input for PUBLIC.

TAPE ASSIGNMENTS IN PUBLIC

PUBLIC uses seven auxiliary disks (eight if punched output is desired) in addition to the input file (card reader) and output file (printer). All logical units are references in the program by variable names LU, LU2, LU3, LU4, LU5, LU6, LU7, LU8, LU9, LU10, which are initialized in the BLOCK DATA subprogram. Because of variations among operating systems, it may be necessary for the user to change these assignments to conform to the operating system being used. Table 2 indicates the function of each of the logical units.

The user also has the option to have individual data records read from an additional unit, if desired (see the section Data Input for PUBLIC for details of this option). If this option is chosen, a numerical value for LUDATA is specified on input, and this value must be distinct from any values assigned to logical units in BLOCK DATA. When this option is not chosen, LUDATA automatically defaults to LU5 (card reader).

Table 2. Functions of logical units.

Variable Name	Function	Assigned Value in BLOCK DATA
LU	Auxiliary disk	1
LU2	Auxiliary disk	2
LU3	Auxiliary disk	3
LU4	Auxiliary disk	4
LU5	Card reader	5
LU6	Printer	6
LU7	Auxiliary disk	7
LU8	Auxiliary disk	8
LU9	Auxiliary disk	9
LU10	Punch file (Hollerith)	10

DATA INPUT FOR PUBLIC

TITLE

Use involves two cards:

1. TITLE (Cols. 1-5)
2. Any alphanumeric characters (Cols. 1-72).

A TITLE command may be inserted anywhere in the analysis schedule, thus titles may be selected to identify the input data or the analysis performed.

DATA

Use involves four cards (in addition to the data records):

1. DATA (Cols. 1-4)
2. NID,NDAT,LUDATA,IWIDE,PRDAT (FORMAT 5I2)
   NID = number of identifier fields, must be $\leq$ 3 (defaults to 3)
   NDAT = number of data fields, must be <80 (defaults to 1)
   LUDATA = number of the input unit containing data (defaults to LU5)
   IWIDE = 1 if carriage width of output unit is less than 120 characters; 0 or blank otherwise.
   PRDAT = 1 if the first 60 data records are desired to be printed out, 0 or blank if no data records are to be printed out.
3. Variable format card (FORMAT 20A4)
4. END (Cols. 1-3)

The individual data records are placed between cards 3 and 4. They are preceded by a format statement describing the data arrangement (card 3). The format may include columns 1-80 on the card or card image. The first and last characters must be left and right parentheses, respectively. Inside the parentheses may be any combination of A, F, X, "/" and numeric descriptors. These A, F, X, "/" and numeric descriptors have the same meaning as in FORTRAN and may be used in any way that is legal in FORTRAN, but with the following restrictions:

(a) The read list for the data cards requires that the identifier fields must precede the data fields (ID(I), I=1,NID), (DATA(J), J=1,NDAT).

(b) Internal storage requires that the identifier fields must be in an A3 or A4 format.

(c) Internal storage requires that the data fields must be in an F format.

(d) The letters END must not be used as the first three identifier characters for any data record, to avoid being read as the END card.

If the data records are to be read from a unit other than the card reader (as specified by LUDATA), they must be formatted according to the variable format card, and must be trailed by an END record.

If the variable format card contains any "/" descriptors, i.e., if multiple record data input is used, the END card must be trailed by as many cards as necessary to complete the multiple record requirement. This prevents the next command card from being read as a data card.

LEVEL

This routine provides the user with a histogram and a set of descriptive statistics. These statistics are mean, variance, standard deviation, standard error, mode, kurtosis, skewness, median and range. LEVEL can be used with either a single data element or a consecutive string of data elements. To use LEVEL, two cards are needed:

1. LEVEL (Cols. 1-5)
2. N1,N2,ICON,IPRIN,EXTOP (FORMAT 5I2).

If a single data element (variable) is to be analyzed, N1 is the position of that element in the data array (DATA(J)), and N2 is zero or blank. If a consecutive string of data elements is to be analyzed, N1 is the position of the first element (variable) to be analyzed and N2 is the position of the last element (variable) to be analyzed. The other variables in the list are not used by subroutine LEVEL and need not be entered. LEVEL may be used on any number of variables, and no restriction is made on the number of observations.

KENDAL

This routine is used to test the amount of agreement among a set of observations consisting of ranked data. The output lists the number of observations, the number of variables, and the concordance coefficient. The instructions are:

1. KENDAL (Cols. 1-6)
2. N1,N2,ICON,IPRIN,EXTOP (FORMAT 5I2)

where N1 and N2 are the positions in the data array of the beginning and ending elements of the set of ranked data to be analyzed. The other variables are not used by subroutine KENDAL and need not be entered. The maximum number of data elements that can be analyzed (N2-N1+1) is 15. No restriction is made on the number of observations.

ORDER

This routine works with individual ranked preference data to produce a single least-disliked preference schedule for use in those cases, such as goal programming, where a single preference order is required. The instructions are:

1. ORDER (Cols. 1-5)
2. N1,N2,ICON,IPRIN,EXTOP (FORMAT 5I2)

where N1 and N2 are the positions in the data array of the beginning and ending elements of the set of ranked data to be analyzed. The other variables are not used in subroutine ORDER and need not be entered. The maximum number of data elements that can be analyzed (N2-N1+1) is 15. No restriction is made on the number of observations.

FACTOR

This routine is an adaptation of conventional factor analysis which uses factor analysis primarily as a means of subdividing respondents into subgroups, each with its own interest configuration.

Factor analysis determines the distribution of individuals in a normal orthogonal space of N dimensions according to standard factor analysis procedures using principal component analysis with varimax rotation. Variables are plotted for interpretive purposes, but such interpretation should be used with caution. If unspecified, two factors are rotated; plot of the two principal dimensions is always presented.

The data are then sorted into 2N+1 groups according to the positions of observations in the factor space. Following these groupings the program is returned to ORDER and KENDAL to conduct these analyses on the subgroups. Finally, an optional analysis is performed which determines the hypothetical data that would give rise to the most extreme positions (positive and negative) on each factor, and these are plotted. Instructions are:

1. FACTOR (Cols. 1-6)
2. N1,N2,ICON,IPRIN,EXTOP (FORMAT 5I2)

where N1 and N2 are the positions in the data array of the beginning and ending elements of the set of ranked data to be analyzed. ICON is the number of factors to be rotated; if unspecified this value defaults to 2. IPRIN determines whether factor scores for each observation are printed or punched. If IPRIN is unspecified or zero, factor scores will neither be printed nor punched. IPRIN=1 causes factor scores to be printed. IPRIN=2 causes factor scores to be punched, one card for each observation, with the individual identifiers included on the punched card. IPRIN=3 will result in factor scores being both printed and punched.

EXTOP represents the optional extreme analysis. If EXTOP is unspecified or zero, the extreme analysis will be performed. If the extreme analysis is not desired, EXTOP must be a positive integer. The maximum number of data elements that can be analyzed (N2-N1+1) is 15. No restriction is made on the number of observations; however, when observations are sorted into the 2N+1 groups, each group can hold at most 1250 observations, and only 2500 individuals will be plotted.

The number of factors rotated (ICON) will ordinarily be 2, but up to 13 are allowed. ICON must be less than the number of data elements (variables) being analyzed.

COMPARE

The COMPARE routine compares a new data set to the factor matrix calculated by FACTOR. To be used, it must follow FACTOR. The new data set may be contained as part of the data array in the original set of data records previously entered in DATA; or alternatively, it may be entered immediately previous to COMPARE with a new DATA sequence. Instructions are:

1. COMPARE (Cols. 1-7)
2. N1,N2,ICON,IPRIN,EXTOP (FORMAT 5I2)

where N1 and N2 are the beginning and ending elements of the new data array. The COMPARE analysis must be preceded by FACTOR, and the values of ICON and (N2-N1) must agree with the base data set on which FACTOR was performed. No restriction is made on the number of observations, but only 2500 individuals will be plotted.

STOP

The command:

1. STOP (Cols. 1-4)

must be given after all desired analyses have been requested in order to achieve a normal exit from the program.

Comments on Data Input

In the PUBLIC system each separate item in the data array is called a *variable*. The response of any individual to a measurement item is called a *value*. Each individual's response to the measurement instrument is located on an individual 80-column card or card image. In the resulting data block, variables are represented by columns, individuals by cards (or card images), and responses by values located in each set of columns. As far as the computer program is concerned, data can be collected in any way. A convenient way, however, is to use data forms designed for use with an optical mark reader (Appendix A). These forms are then transferred by machine to punched cards or magnetic tape (in formatted card image) for analysis (see Sample Problem, Fig. 11).

Although PUBLIC will accept many different data formats, a convenient arrangement is shown in the following example.

Group	Description
Identification System	The first set of variables in Cols. 1-4 of the data record refers to the survey number. The second set (Cols. 5-8) includes a subgroup identifier (such as a ZIP code). The third set (Cols. 9-12) is an individual respondent identifier. The individual respondent identifier may be blanked out to assure confidential responses, but this will prevent identification of those responses as members of the groups in FACTOR.
Rank Order of Land Uses	It is assumed that the investigator is examining 15 or fewer land uses. Each land use variable is entered with a value in the data record. The variables are the items; the value of this variable identifies which priority has been indicated. Two or more blocks of priority rankings may be included in the data.

Activity Levels for Each Land Use Value	For these data, variables describe the activity level for each of the alternative land uses. Each variable represents one of the alternative land uses and the values taken by the variables describe activity levels on a scale of 1 to 5. Activity levels should be analyzed only by the LEVEL routine.

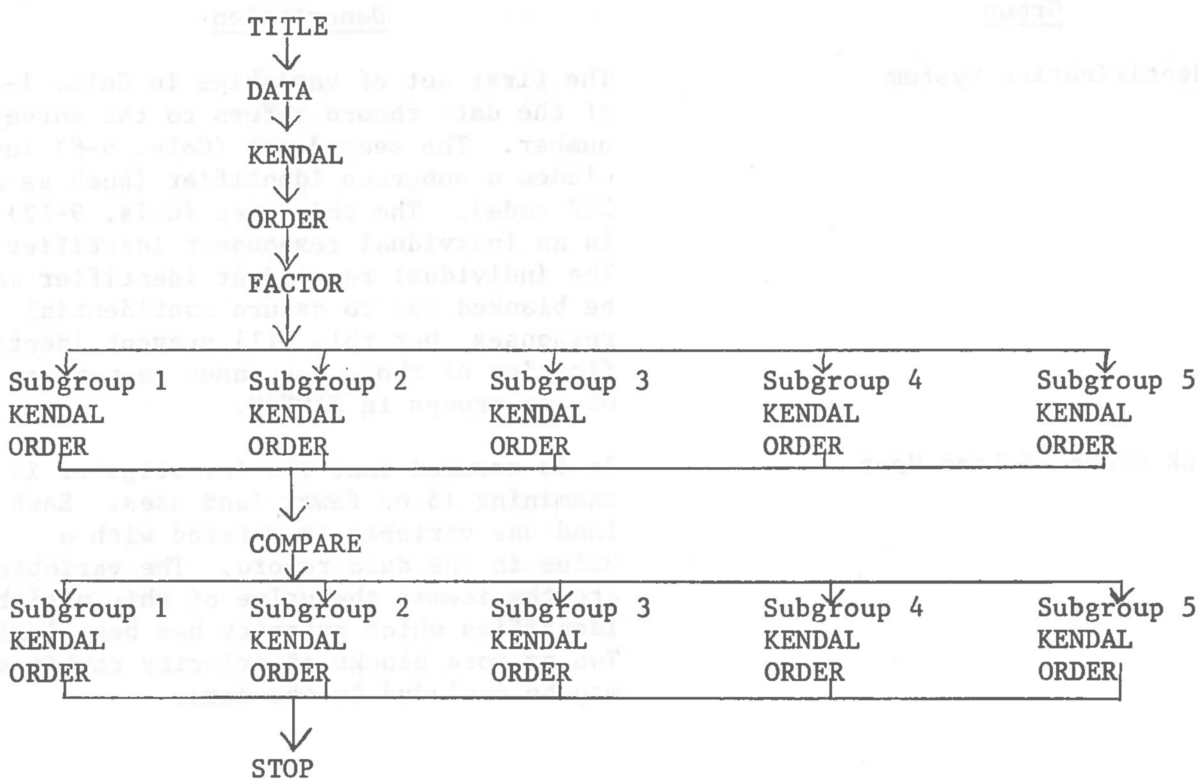
The header block indicates the number of identifier fields (ordinarily 3) and number of variables; a trailer card (END) is used to indicate the end of a data set, so a count of observations is not necessary.

For data which concerns levels of use only (routine LEVEL), the width of each field can be expanded. A typical format for 10 items might allow six columns for each item beginning in Col. 13.

Ranked data are treated in a special fashion. These data are ordered so that an entry of 1 indicates first priority and an entry of N indicates last priority. The entire field should have only one entry for each rank; any other combination of entries will be rejected.

Data Analysis Sequence

The sequence of analytical steps can actually be in any order, but normally a sequence should be followed for each data type. For preference order data, the following procedure is suggested:



For activity level data and output level data, only the use of the LEVEL routine is suggested.

OUTPUT FROM PUBLIC

Output from PUBLIC has been designed for full utilization of the type of printer or terminal being used. If the carriage width is at least 120 characters (IWIDE is 0 or blank in Cols. 7-8 of card 2 of the TITLE sequence), output is complete, and the entire available width is used. When an interactive terminal is being used with a carriage width of less than 120 characters (IWIDE is positive), output is reduced somewhat because of time considerations, and width of tables is adjusted for the narrow carriage width.

The following is a general description of the output from each analysis or command. Output from each routine is shown following the sample problem in Sample Problem Output.

TITLE

An alphanumeric title entered after this command appears as part of the heading for output from any subsequent analyses.

DATA

When full carriage width is available, individual data records input may be printed out (up to a maximum of 60) if desired, by setting PRDAT=1 in Cols. 9-10 of card 2 of the DATA sequence. If this option is invoked, entries in the data records are printed out in an F3.0 format, which is suitable for all ranked data and for activity level data that does not require an increased field width. This option should not be used where activity level data requires greater field width. See Sample Problem Output A and K for output from this option.

Exclusion of Invalid Data

Preceding any analysis which requires ranked data (KENDAL, ORDER, FACTOR, or COMPARE) input data is checked to insure for each observation that every variable to be considered in the analysis has been ranked and that each rank has been used exactly once. If any observation fails to meet these criteria, it is not used in that analysis, and a list of the excluded data records and the invalid data sets is printed immediately before the output for the requested analysis. See Sample Problem Output B.

LEVEL

Output from LEVEL includes a set of descriptive statistics (mean, variance, standard deviation, standard error, skewness, kurtosis, mode, median, range, maximum and minimum) and a histogram representing the percentage of responses falling in up to 13 distinct categories. Where the number of distinct responses exceeds 13, responses are grouped so that only 10 categories of responses are graphed. Output is shown in Sample Problem Output G, H, I, and J.

KENDAL

Output from KENDAL includes the number of observations used in the calculations, the number of variables ranked, and the Kendall concordance coefficient. When the number of variables (M) is greater than 7, a value for the chi-square with M-1 degrees of freedom is printed out also. This value represents the significance of the Kendall concordance coefficient. When it exceeds the chi-square value found in any chi-square table at a particular level of significance, the null hypothesis (that the observations are unrelated) may be rejected at that level of significance. Output is shown in Sample Problem Output C and M.

ORDER

Output from ORDER is the single priority ranking of the variables satisfactory to the majority of individuals whose priority rankings compose the data. Output is shown in Sample Problem Output D.

FACTOR

Output from FACTOR includes the number of cases (valid observations) considered in the analysis, and the number of variables being analyzed.

Next, the means and standard deviations for the responses to each variable are printed, followed by the matrix of correlation coefficients between the variables, and the proportion of eigenvalues or variance extracted by each unrotated factor. If an interactive terminal is being used for output and the number of variables exceeds six, means, standard deviations, matrix of correlation coefficients and proportion of eigenvalues will not be printed.

The rotated factor matrix is then printed out, containing the factor loadings on each rotated factor for each of the variables. Also, variables are given alphabetic identifiers so that they may be located on the subsequent plot. (When the number of rotated factors exceeds six, the rotated factor matrix is omitted from the output for an interactive terminal.)

The variables are then plotted on pairs of axes (corresponding to pairs of factors) according to their factor loadings for those factors. When two factors have been rotated, there will be only one graph, with axes representing the two factors. When more than two factors have been rotated (i.e., when ICON > 2 in Cols. 5-6 of card 2 of the FACTOR card sequence) each distinct pair of factors appears as a pair of axes on a separate graph. However, no more than six graphs will be plotted. These will have as axes, respectively: factor 1 vs. factor 2, factor 1 vs. factor 3, factor 1 vs. factor 4, factor 2 vs. factor 3, factor 2 vs. factor 4, and factor 3 vs. factor 4.

Factor scores for each observation are then printed if this has been requested (IPRIN=1 or 3 in Cols. 7-8 of card 2 of the FACTOR card sequence), followed by the average of the factor scores for all observations. The average is always printed (irrespective of IPRIN) as a check, since it is known that the average values should be zero for the base data set. If IPRIN=2 or 3, factor scores and individual identifiers are punched, one card per observation, in the format (3A4,13F5.2).

Individuals are then sorted into groups according to their factor scores, i.e., according to their position in the N-dimensional factor space. The number of groups identified depends on the number of rotated factors. If N factors are rotated, there are 2N+1 groups.

The first group identified consists of individuals closest to the average, i.e., those whose factor scores are within a certain distance from zero on all factors. The remaining groups consist of individuals who are most closely identified with either the positive or negative extremes of each factor. An individual will be in the positive or negative group for a particular factor if (i) he is not in the group closest to average, and (ii) his largest factor score (in absolute value) is on that factor. He will be in the positive group if that score is positive, and the negative group if that score is negative.

In terms of the N-dimensional factor space, the group closest to average consists of those individuals lying in a cube (or hypercube) about the origin, while the remaining groups are made up of those individuals falling in the truncated pyramid (or hyperpyramid) symmetric about the semi-axis corresponding to the factor in question. Fig. 10 shows the location of the five groups for the two-dimensional case N=2.

For each group identified, the identification fields of the members are printed out (so long as the individual identifier field, i.e., the third identifier field, has not been blanked out), together with their scores on the factor with which they have been associated. For the group closest to average, their diagonal distance from the average position (the origin) is printed.

This is followed by the Kendall concordance coefficient for the group, and the single priority ranking (order) most satisfactory to that group.

A plot (or set of plots for more than two factors) of the location of the individuals in the factor space is then presented, with numbers indicating the number of individuals at each location. Also included in this plot is the rectangle enclosing the group closest to average.

If the extreme analysis has been requested (EXTOP is 0 or blank in Cols. 9-10 of card 2 of the FACTOR sequence), the next output shows those hypothetical priority rankings which would lead to the most extreme (positive and negative) factor scores on each factor. A plot (or set of plots) is then presented indicating where an individual who chose such a ranking would be located in the factor space.

Output from FACTOR is shown in Sample Problem Output E.

COMPARE

Output from the COMPARE analysis begins with a description of the data set being analyzed, identifying the variables, the data set, the number of observations, and number of variables used in the analysis. The means and standard deviations for each variable are printed, followed by factor scores for each observation if this has been requested (IPRIN=1 or 3 in Cols. 7-8 of card 2 of the COMPARE card sequence). If punched factor scores are requested (IPRIN=2 or 3), individual identifiers and factor scores are punched, one card per observation, in the format (3A4,13F5.2).

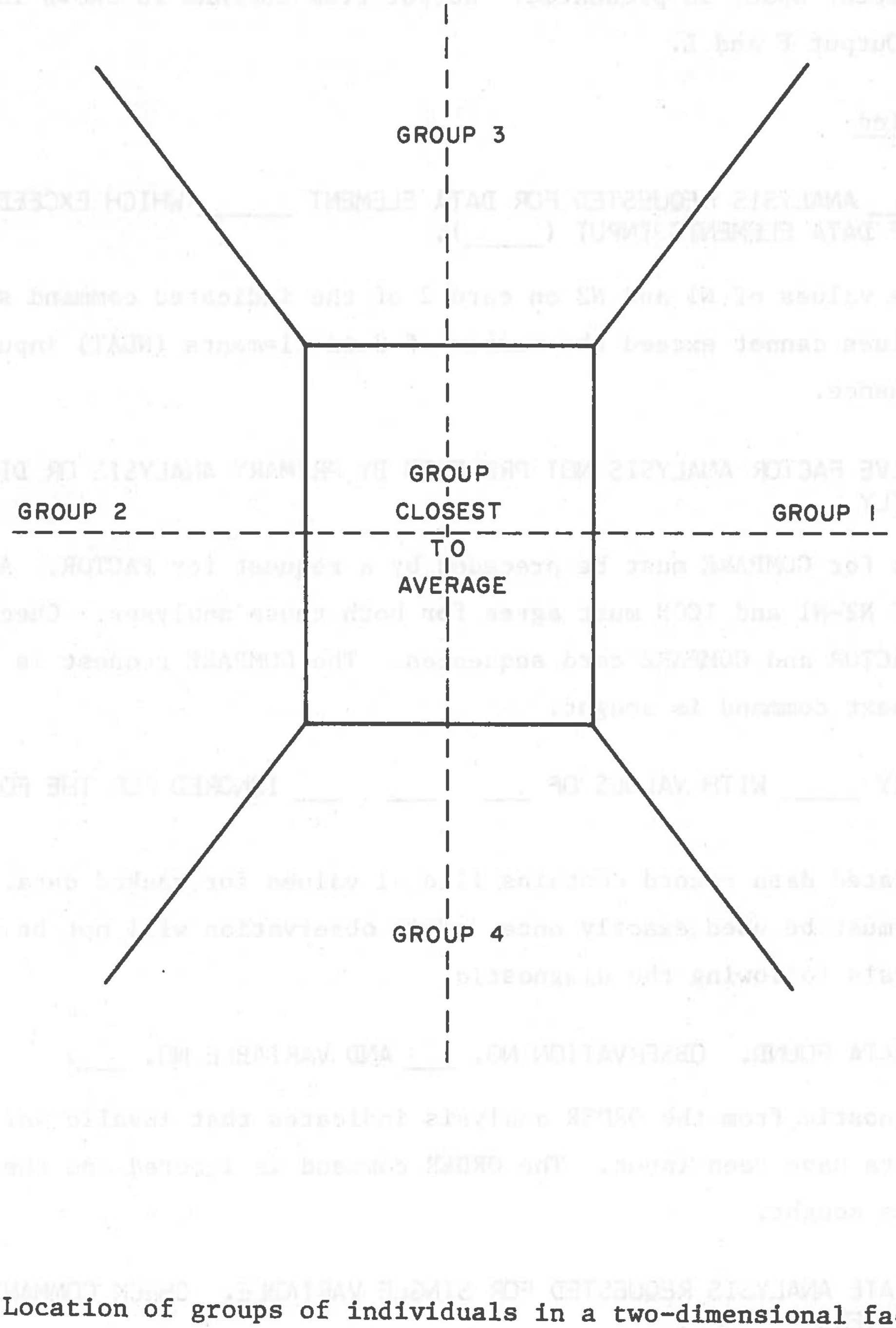


Fig. 10. Location of groups of individuals in a two-dimensional factor space.

Individuals are then sorted into groups based on their factor scores (as in FACTOR) and the results of the KENDAL and ORDER analyses for each group are printed out. Finally, a plot of the location of the individuals in the factor space is presented. Output from COMPARE is shown in Sample Problem Output F and L.

Diagnostics

__________ ANALYSIS REQUESTED FOR DATA ELEMENT ______ WHICH EXCEEDS TOTAL NUMBER OF DATA ELEMENTS INPUT (_____).

Check the values of N1 and N2 on card 2 of the indicated command sequence. These values cannot exceed the number of data elements (NDAT) input in the DATA sequence.

COMPARATIVE FACTOR ANALYSIS NOT PRECEDED BY PRIMARY ANALYSIS OR DIMENSIONED DIFFERENTLY.

A request for COMPARE must be preceded by a request for FACTOR. Also the values of N2-N1 and ICON must agree for both these analyses. Check card 2 of the FACTOR and COMPARE card sequences. The COMPARE request is ignored, and the next command is sought.

DATA ENTRY _____ WITH VALUES OF ___ ___ ___ IGNORED FOR THE FOLLOWING ANALYSIS.

The indicated data record contains illegal values for ranked data. Each priority must be used exactly once. This observation will not be used in the analysis following the diagnostic.

ILLEGAL DATA FOUND. OBSERVATION NO. ___ AND VARIABLE NO. ___.

This diagnostic from the ORDER analysis indicates that invalid values for ranked data have been input. The ORDER command is ignored and the next command is sought.

MULTIVARIATE ANALYSIS REQUESTED FOR SINGLE VARIABLE. CHECK COMMAND __________ AND PARAMETERS _______.

Check card 2 of the indicated command sequence for the values of N1 and N2, which must be the first and last data elements (variables), respectively, to be used in the analysis requested, and which cannot be equal to each other.

NUMBER OF IDENTIFICATION FIELDS EXCEEDS THREE.

The number of identification fields must be ≤ 3. Check card 2 of the DATA sequence for the value of NID (Cols. 1-2), and adjust variable format card if necessary.

NUMBER OF ROTATED FACTORS MUST BE LESS THAN NUMBER OF VARIABLES. ROTATION OF A MAXIMUM OF ___ FACTORS POSSIBLE. FACTOR ANALYSIS CONTINUES WITH ICON RESET TO ____.

The input value of ICON is greater than or equal to the number of variables (N2-N1+1). ICON is reduced accordingly, and factor analysis continues with the reduced number of rotated factors.

OVERFLOW OF CLASS WITH OBSERVATION _____. VALUE = _________.

A maximum of 1250 observations per group will be listed. The indicated observation will not be listed.

TOTAL NUMBER OF DATA ELEMENTS EXCEEDS 80.

A maximum of 80 data elements (variables) can be read in the DATA sequence of PUBLIC. Check the value of NDAT in Cols. 3-4 of card 2 of the DATA sequence, and adjust the variable format card (card 3), if necessary.

UNRECOGNIZED COMMAND _____________.

A command is misspelled or in the wrong columns. Command words must begin in Col. 1. If multiple record data input has been used (i.e., if a "/" is included in the variable format card), check that this has not caused a command card to be skipped. (See DATA section of Data Input for PUBLIC.) Program execution stops.

_______ VARIABLES HAVE STANDARD DEVIATIONS OF ZERO. MEANINGFUL FACTOR ANALYSIS NOT POSSIBLE ON THIS DATA SET.

The number of variables whose standard deviation is not zero must exceed the number of factors rotated in order for the factor scores to have any significance. If there are not at least three variables with non-zero standard deviations, factor analysis is meaningless.

_________ VARIABLES HAVE STANDARD DEVIATIONS OF ZERO. ROTATION OF A MAXIMUM OF _____ FACTORS POSSIBLE. FACTOR ANALYSIS CONTINUES WITH ICON RESET TO _____.

Meaningful factor analysis can be performed as long as the number of rotated factors (ICON) is smaller than the number of variables with non-zero standard deviations. This diagnostic indicates that the number of factors requested to be rotated was too large, and that the analysis goes on with the value of ICON reduced accordingly.

SAMPLE PROBLEM

Data Input for Sample Problem

In the following hypothetical case example, 22 responses were received to the questionnaire shown as Appendix B. Each response contains two sets of rankings for each of six land use preference items, as well as a use level (from "very frequent" to "never") for each preference item. Figure 11 shows a questionnaire that has been filled in (a), the coding for the data records for that set of responses (b), and the variable format card (c) that precedes all 22 of the data records. In addition, we have five hypothetical responses to question 1 of the questionnaire from agency personnel which we wish to compare to the other 22 responses.

Figure 12 shows the coding for the entire data deck for the sample problem.

Card 1 contains the command TITLE, indicating that the following card contains the problem title.

Card 2 contains the alphanumeric problem title.

Card 3, DATA, denotes that a data set is to follow.

Card 4 contains the parameters of the data set. The entry in Cols. 1-2 indicates that NID=3, i.e., that three 4-character alphanumeric identifier fields will be used. The entry in Cols. 3-4 indicates that NDAT=18, since there are 18 responses on each questionnaire, yielding 18 data fields. Columns 5-6 are blank denoting that data to be read from input unit 5 (card reader). The

(a)

H

ANSWER SHEET

NOTE: THIS ANSWER SHEET WILL BE SCORED WITH AN OPTICAL MARK READER. FILL IN ONE SPOT PER ROW WITH A SOFT BLACK PENCIL ONLY (NO. 2 OR NO. 2 1/2). FILL IN THE SPOT COMPLETELY. IF YOU CHANGE YOUR MIND, ERASE CLEANLY.

1. INDICATE YOUR VIEWS OF NATURAL RESOURCE PRIORITIES. MARK PRIORITIES FOR ITEMS INDICATING ONLY ONE PRIORITY PER ROW AND A DIFFERENT PRIORITY FOR EACH ROW.

	PRIORITY					
	1	2	3	4	5	6
RANGE MANAGEMENT.......	●	0	0	0	0	0
TIMBER MANAGEMENT......	0	0	0	●	0	0
DEVELOPED RECREATION...	0	0	0	0	●	0
SCENIC BEAUTY..........	0	0	0	0	0	●
WILDERNESS.............	0	●	0	0	0	0
WILDLIFE MANAGEMENT....	0	0	●	0	0	0

2. INDICATE YOUR VIEWS OF HOW THE REGIONAL AGENCIES SET PRIORITIES. MARK ONLY ONE PRIORITY PER ROW AND A DIFFERENT PRIORITY FOR EACH ROW.

	PRIORITY					
	1	2	3	4	5	6
RANGE MANAGEMENT.......	0	0	0	0	0	●
TIMBER MANAGEMENT......	0	0	0	0	●	0
DEVELOPED RECREATION...	0	●	0	0	0	0
SCENIC BEAUTY..........	0	0	●	0	0	0
WILDERNESS.............	●	0	0	0	0	0
WILDLIFE MANAGEMENT....	0	0	0	●	0	0

3. INDICATE YOUR PARTICIPATION IN, OR ORGANIZATION MEMBERSHIP RELATED TO, EACH OF THE NATURAL RESOURCE ITEMS. MAKE ONLY ONE MARK PER ROW.

	VERY FREQUENT	FREQUENT	OCCASIONAL	SELDOM	NEVER
RANGE MANAGEMENT.....	●	0	0	0	0
TIMBER MANAGEMENT....	0	0	0	0	●
DEVELOPED RECREATION.	0	0	0	0	●
SCENIC BEAUTY........	0	0	0	0	●
WILDERNESS...........	0	●	0	0	0
WILDLIFE MANAGEMENT..	0	0	●	0	0

SURVEY NUMBER SN01 ZIP CODE 8052 (FIRST FOUR DIGITS ONLY)
PLACE THIS ANSWER SHEET IN THE ENCLOSED ENVELOPE AND MAIL.

FORM NO. 803

(b)

```
SN018052  1  145623  652314  511143
```

(c)

```
(3A4,3(2X,6F1.0))
```

Fig. 11. Coding of data records: (a) questionnaire with responses marked; (b) card image of coded responses; (c) variable format card.

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

TITLE
SAMPLE PROBLEM
DATA
0318   01
(3A4,3(2X,6F1.0))
SN018052   1  145623  652314  511143
SN018052   2  625431  354621  131235
SN018052   3  532146  625341  132511
SN018052   4  625431  256431  131225
SN018052   5  625341  245316  131224
SN018052   6  625413  254631  131253
SN018052   7  365421  645321  211235
SN018052   8  645321  125643  111355
SN018052   9  654213  541236  112554
SN018052  10  654132  254316  111545
SN018052  11  654213  523146  111455
SN018052  12  123456  643125  533111
SN018052  13  463251  351246  313425
SN018052  14  654321  245136  111444
SN018052  15  432165  564231  223511
SN018052  16  423561  624315  222215
SN018052  17  245631  542316  411125
SN018052  18  645321  543216  121345
SN018052  19  643125  312456  112512
SN018052  20  631245  542136  134421
SN018052  21  643125  612453  113551
SN018052  22  113564  645312  552211
END
KENDAL
0106
ORDER
0106
FACTOR
0106  01
COMPARE
0712   01
LEVEL
1315
LEVEL
17
DATA
0306   01
(3A4,2X,6F1.0)
AN01USFS   1  625341
AN01SCS    2  645231
AN01OSIS   3  463512
AN01FBI    4  625431
AN01CIA    5  654321
END
COMPARE
0106  01
KENDAL
0106
STOP
```

Fig. 12. Coded input data for sample problem.

zero entry in Cols. 7-8 indicates that the output unit has at least a 120-character field width available for printing. Finally Cols. 9-10 contain a non-zero entry for PRDAT indicating that we wish to have the input data printed out.

Card 5 is the variable format card indicating how the data is arranged. In this example, we have three A4 fields for identifiers, followed by three sets of 6F1.0 fields for the responses, separated by two spaces (2X) (Fig. 12).

Cards 6-27 contain the coded data from the returned questionnaires (see Fig. 12). The first identifier field contains the survey number, the second contains the first four digits of the ZIP code, and the third contains individual identifier numbers. Responses to the first two questions are coded in Cols. 15-20 and 23-28, respectively. Observe that these are coded in the order: priority ranking of item 1 (range management), priority ranking of item 2 (timber management), etc., through priority ranking of item 6 (wildlife management). For question 3, the values 5, 4, 3, 2, and 1, respectively, are assigned to the responses "very frequent," "frequent," "occasional," "seldom," and "never." Note that in this example, respondent 22 (card 27, Fig. 12) has filled in his questionnaire incorrectly, using priority 1 twice in his answer to question 1. His response to this question will be omitted from any analysis of ranked data.

Card 28 contains the command END, indicating the end of the individual data records.

Card 29 contains the command KENDAL indicating that Kendall's concordance coefficient is to be calculated for the set of rankings indicated on the following card.

Card 30 indicates what variables are to be used in calculating the Kendall coefficient. Columns 1-2 contain the beginning element of the data array (N1=1), and Cols. 3-4 the ending element (N2=6). Thus the Kendall coefficient will be calculated for variables 1-6, i.e., for the responses to the first question on the questionnaire (Fig. 11).

Card 31 contains the command ORDER, indicating that a single priority ranking is to be found which is satisfactory to the majority of people responding to the variables indicated on the next card.

Card 32 indicates N1=1 and N2=6 so that we are dealing with the first six data elements, i.e., the six responses to the first question on the questionnaire.

Card 33 contains the command FACTOR, requesting that factor analysis be performed on the variables indicated on the next card.

Card 34 indicates on what data elements the factor analysis is to be performed. Columns 1-2 have N1=1 and Cols. 3-4 have N2=6, so that the factor analysis is done on the first six data items. Columns 5-6 are blank so that the number of rotated factors (ICON) is two. Columns 7-8 indicate IPRIN=1, so that the factor scores will be printed out for each observation. Columns 9-10 are blank since the extreme analysis is desired.

Card 35 contains the command COMPARE, indicating that the responses to the variables listed on the next card are to be compared with those examined in the factor analysis, and plotted on the same factor axes.

Card 36 indicates N1=7 and N2=12, so that the COMPARE analysis is to be done on the 7th through the 12th data items (corresponding to the six responses to the second question on the questionnaire). Thus the perceived priority rankings are compared to the individuals' own priority rankings.

Card 37 contains the command LEVEL indicating that we wish to have an analysis done of the use levels for the variables indicated on the next card.

Card 38 shows N1=13 and N2=15 so that the LEVEL analysis is done on the 13th, 14th and 15th data items (corresponding to "range management," "timber management," and "developed recreation" in question 3 of the questionnaire).

Card 39 contains the command LEVEL, requesting another use level analysis for the variable listed on the next card.

Card 40 shows N1=17 with no entry for N2, so that the LEVEL analysis is done on the 17th data item only (corresponding to "wilderness" in question 3 of the questionnaire).

We have now completed our requests for all the analyses we wished to have done on the first data set of 22 responses. Further analyses are to be performed on the second data set (the five responses from agency personnel). This new data set is now read in.

Card 41 contains the DATA command, indicating that a new data set is to follow.

Card 42 contains the parameters of the new data set. NID=3 (Cols. 1-2) indicating that three alphanumeric identifier fields are used. NDAT=6 (Cols. 3-4), since there are six data items on each card (corresponding to six answers on the questionnaire). Columns 5-6 are blank, indicating that input unit 5 is to be used, since the data is coming from cards. Columns 7-8 are blank since full carriage width is available. Columns 9-10 contain a 1 indicating that we wish to have the data printed out.

Card 43 is the variable format card for the new data set.

Cards 44-48 contain the coded responses to the questionnaire.

Card 49, END, denotes the end of this data set.

Card 50, COMPARE, requests that the new data set be compared with the factor matrix generated from the previous data set (on which factor analysis was performed).

Card 51 indicates N1=1 (Cols. 1-2) and N2=6 (Cols. 3-4) so that the COMPARE analysis will be done on the first six data items of the new data set. Thus agency responses will be compared to the individuals' responses.

Card 52 contains the command KENDAL requesting that Kendall's concordance coefficient be calculated for the new data set.

Card 53 shows N1=1 and N2=6, denoting that the KENDAL analysis is to be done on data items 1 through 6 of the new data set.

Card 54, STOP, indicates that no further analyses are to be done.

Sample Problem Output

The following is the complete output from PUBLIC for the example problem whose data input is shown in Fig. 12.

A.

DATA SET 1 (FIRST 60 OBSERVATIONS) FOR
SAMPLE PROBLEM

SN018052	1	1.	4.	5.	6.	2.	3.	6.	5.	2.	3.	1.	4.	5.	1.	1.	1.	4.	3.
SN018052	2	6.	2.	5.	4.	3.	1.	3.	5.	4.	6.	2.	1.	1.	3.	1.	2.	3.	5.
SN018052	3	5.	3.	2.	1.	4.	6.	6.	2.	5.	3.	4.	1.	1.	3.	2.	5.	1.	1.
SN018052	4	6.	2.	5.	4.	3.	1.	2.	5.	6.	4.	3.	1.	1.	3.	1.	2.	2.	5.
SN018052	5	6.	2.	5.	3.	4.	1.	2.	4.	5.	3.	1.	6.	1.	3.	1.	2.	2.	4.
SN018052	6	6.	2.	5.	4.	1.	3.	2.	5.	4.	6.	3.	1.	1.	3.	1.	2.	5.	3.
SN018052	7	3.	6.	5.	4.	2.	1.	6.	4.	5.	3.	2.	1.	2.	1.	1.	2.	3.	5.
SN018052	8	6.	4.	5.	3.	2.	1.	1.	2.	5.	6.	4.	3.	1.	1.	1.	3.	5.	5.
SN018052	9	6.	5.	4.	2.	1.	3.	5.	4.	1.	2.	3.	6.	1.	1.	2.	5.	5.	4.
SN018052	10	6.	5.	4.	1.	3.	2.	2.	5.	4.	3.	1.	6.	1.	1.	1.	5.	4.	5.
SN018052	11	6.	5.	4.	2.	1.	3.	5.	2.	3.	1.	4.	6.	1.	1.	1.	4.	5.	5.
SN018052	12	1.	2.	3.	4.	5.	6.	6.	4.	3.	1.	2.	5.	5.	3.	3.	1.	1.	1.
SN018052	13	4.	6.	3.	2.	5.	1.	3.	5.	1.	2.	4.	6.	3.	1.	3.	4.	2.	5.
SN018052	14	6.	5.	4.	3.	2.	1.	2.	4.	5.	1.	3.	6.	1.	1.	1.	4.	4.	4.
SN018052	15	4.	3.	2.	1.	6.	5.	5.	6.	4.	2.	3.	1.	2.	2.	3.	5.	1.	1.
SN018052	16	4.	2.	3.	5.	6.	1.	6.	2.	4.	3.	1.	5.	2.	2.	2.	2.	1.	5.
SN018052	17	2.	4.	5.	6.	3.	1.	5.	4.	2.	3.	1.	6.	4.	1.	1.	1.	2.	5.
SN018052	18	6.	4.	5.	3.	2.	1.	5.	4.	3.	2.	1.	6.	1.	2.	1.	3.	4.	5.
SN018052	19	6.	4.	3.	1.	2.	5.	3.	1.	2.	4.	5.	6.	1.	1.	2.	5.	1.	2.
SN018052	20	6.	3.	1.	2.	4.	5.	5.	4.	2.	1.	3.	6.	1.	3.	4.	4.	2.	1.
SN018052	21	6.	4.	3.	1.	2.	5.	6.	1.	2.	4.	5.	3.	1.	1.	3.	5.	5.	1.
SN018052	22	1.	1.	3.	5.	6.	4.	6.	4.	5.	3.	1.	2.	5.	5.	2.	2.	1.	1.

B.

DATA ENTRY SN018052 22
WITH VALUES OF 1. 1. 3. 5. 6. 4.
IGNORED FOR THE FOLLOWING ANALYSIS

C.

KENDALL CONCORDANCE COEFFICIENT FOR
SAMPLE PROBLEM
FOR VARIABLE 1 THROUGH VARIABLE 6 OF DATA SET 1

NUMBER OF OBSERVATIONS 21

NUMBER OF VARIABLES 6

KENDALL COEFFICIENT= .185

DATA ENTRY SN018052 22
WITH VALUES OF 1. 1. 3. 5. 6. 4.
IGNORED FOR THE FOLLOWING ANALYSIS

D.

ORDER ANALYSIS FOR
SAMPLE PROBLEM
FOR VARIABLE 1 THROUGH VARIABLE 6 OF DATA SET 1

VARIABLES ORDERED AS FOLLOWS

VARIABLE	RANK
1	6
2	5
3	4
4	3
5	2
6	1

DATA ENTRY SNO16052 22
WITH VALUES OF 1. 1. 3. 5. 6. 4.
IGNORED FOR THE FOLLOWING ANALYSIS

E.

FACTOR ANALYSIS.....
SAMPLE PROBLEM
FOR VARIABLE 1 THROUGH VARIABLE 6 OF DATA SET 1

NO. OF CASES 21
NO. OF VARIABLES 6

VARIABLE NUMBERS	1	2	3	4	5	6
MEANS	4.85714	3.66667	3.85714	2.95238	3.00000	2.66667
STANDARD DEVIATIONS	1.74028	1.35401	1.23635	1.59613	1.54919	1.90613

CORRELATION COEFFICIENTS

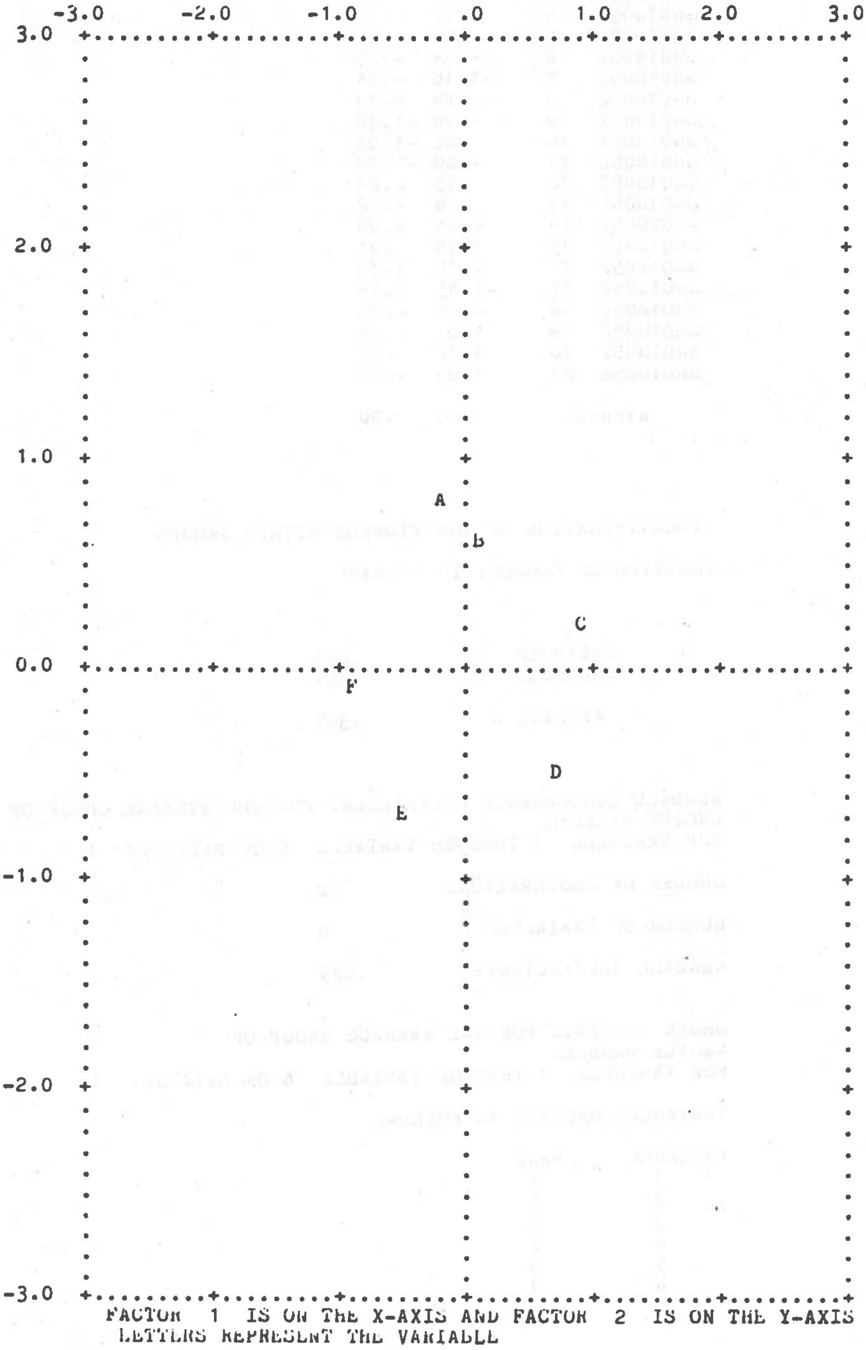
ROW 1	1.00000	-.02122	-.00996	-.57659	-.35237	-.12058
ROW 2	-.02122	1.00000	.05974	-.26220	-.38139	-.20019
ROW 3	-.00996	.05974	1.00000	.57914	-.54820	-.72136
ROW 4	-.57659	-.26220	.57914	1.00000	-.02022	-.48207
ROW 5	-.35237	-.38139	-.54820	-.02022	1.00000	.15239
ROW 6	-.12058	-.20019	-.72136	-.48207	.15239	1.00000

PROPORTION OF EIGENVALUES

.39424	.29652	.16800	.11669	.02456	.00000

ROTATED FACTOR MATRIX (2 FACTORS)

VARIABLE 1=A	-.17918	.76447
VARIABLE 2=B	.11665	.55855
VARIABLE 3=C	.93434	.16125
VARIABLE 4=D	.76809	-.56205
VARIABLE 5=E	-.43789	-.71026
VARIABLE 6=F	-.81259	-.13466


-3.0
-2.0
-1.0
.0
1.0
2.0
3.0
A
B
C
D
E
F
FACTOR 1 IS ON THE X-AXIS AND FACTOR 2 IS ON THE Y-AXIS
LETTERS REPRESENT THE VARIABLE

FACTOR SCORES

SN018052	1	-1.25	1.21
SN018052	2	-.77	.19
SN018052	3	1.74	.19
SN018052	4	-.77	.19
SN018052	5	-.45	.23
SN018052	6	-.64	-.25
SN018052	7	-1.16	-.24
SN018052	8	-.74	-.73
SN018052	9	-.00	-1.30
SN018052	10	.26	-1.03
SN018052	11	-.00	-1.30
SN018052	12	.75	2.24
SN018052	13	.28	-.02
SN018052	14	-.46	-.90
SN018052	15	1.74	.91
SN018052	16	-.10	1.79
SN018052	17	-1.45	1.14
SN018052	18	-.74	-.73
SN018052	19	1.03	-.89
SN018052	20	1.72	.19
SN018052	21	1.03	-.89
AVERAGE		-.00	.00

IDENTIFICATION OF INDIVIDUALS WITHIN GROUPS

INDIVIDUALS CLOSEST TO AVERAGE

SN018052	13	.286
SN018052	5	.509
AVERAGE =		.397

KENDALL CONCORDANCE COEFFICIENT FOR THE AVERAGE GROUP OF
SAMPLE PROBLEM
FOR VARIABLE 1 THROUGH VARIABLE 6 OF DATA SET 1

NUMBER OF OBSERVATIONS 2

NUMBER OF VARIABLES 6

KENDALL COEFFICIENT= .629

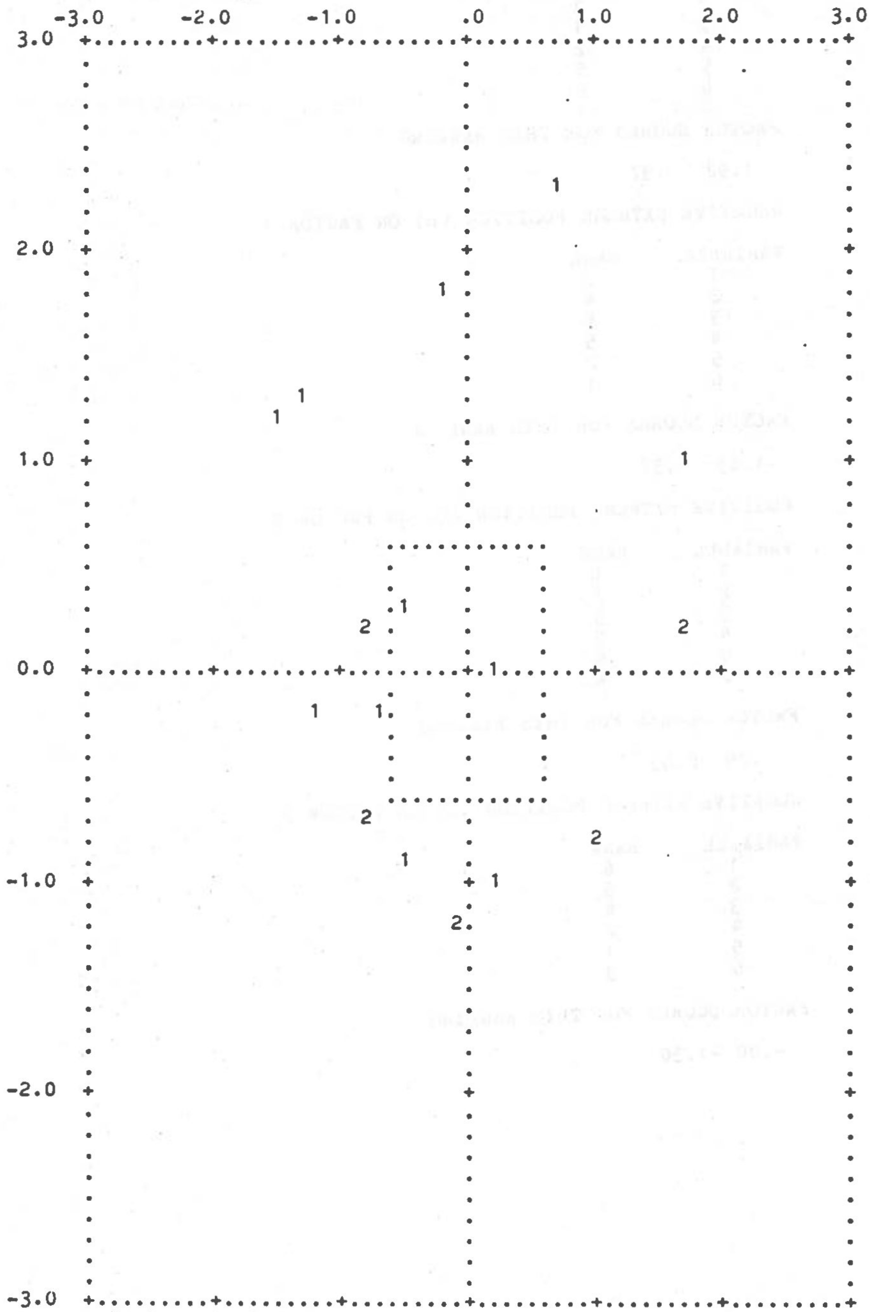
ORDER ANALYSIS FOR THE AVERAGE GROUP OF
SAMPLE PROBLEM
FOR VARIABLE 1 THROUGH VARIABLE 6 OF DATA SET 1

VARIABLES ORDERED AS FOLLOWS

VARIABLE	RANK
1	6
2	5
3	4
4	2
5	3
6	1

```
GROUP   1--POSITIVE ON FACTOR 1
        SN010052   3          1.740
        SN010052  15          1.740
        SN010052  20          1.720
        SN010052  21          1.031
        SN010052  19          1.031

         AVERAGE =            1.453


KENDALL CONCORDANCE COEFFICIENT FOR GROUP   1 OF
SAMPLE PROBLEM
FOR VARIABLE  1 THROUGH VARIABLE  6 OF DATA SET  1

NUMBER OF OBSERVATIONS           5

NUMBER OF VARIABLES              6

KENDALL COEFFICIENT=          .771


ORDER ANALYSIS FOR GROUP   1 OF
SAMPLE PROBLEM
FOR VARIABLE  1 THROUGH VARIABLE  6 OF DATA SET  1

VARIABLES ORDERED AS FOLLOWS

VARIABLE      RANK
     1          6
     2          3
     3          2
     4          1
     5          4
     6          5


GROUP   2--NEGATIVE ON FACTOR 1
        SN010052  17         -1.450
        SN010052   1         -1.254
        SN010052   7         -1.161
        SN010052   2          -.774
        SN010052   4          -.774
        SN010052  18          -.742
        SN010052   8          -.742
        SN010052   6          -.643

         AVERAGE =            -.942


KENDALL CONCORDANCE COEFFICIENT FOR GROUP   2 OF
SAMPLE PROBLEM
FOR VARIABLE  1 THROUGH VARIABLE  6 OF DATA SET  1

NUMBER OF OBSERVATIONS           8

NUMBER OF VARIABLES              6

KENDALL COEFFICIENT=          .536


ORDER ANALYSIS FOR GROUP   2 OF
SAMPLE PROBLEM
FOR VARIABLE  1 THROUGH VARIABLE  6 OF DATA SET  1

VARIABLES ORDERED AS FOLLOWS

VARIABLE      RANK
     1          6
     2          3
     3          5
     4          4
     5          2
     6          1
```

```
GROUP   3--POSITIVE ON FACTOR 2
        SR018052  12        2.236
        SR018052  16        1.786

         AVERAGE =          2.011


KENDALL CONCORDANCE COEFFICIENT FOR GROUP   3 OF
SAMPLE PROBLEM
FOR VARIABLE  1 THROUGH VARIABLE  6 OF DATA SET  1

NUMBER OF OBSERVATIONS          2

NUMBER OF VARIABLES             6

KENDALL COEFFICIENT=         .486


ORDER ANALYSIS FOR GROUP   3 OF
SAMPLE PROBLEM
FOR VARIABLE  1 THROUGH VARIABLE  6 OF DATA SET  1

VARIABLES ORDERED AS FOLLOWS

VARIABLE      RANK
     1          1
     2          2
     3          4
     4          5
     5          6
     6          3



GROUP   4--NEGATIVE ON FACTOR 2
        SR018052   9      -1.296
        SR018052  11      -1.296
        SR018052  10      -1.033
        SR018052  14       -.900

         AVERAGE =        -1.131


KENDALL CONCORDANCE COEFFICIENT FOR GROUP   4 OF
SAMPLE PROBLEM
FOR VARIABLE  1 THROUGH VARIABLE  6 OF DATA SET  1

NUMBER OF OBSERVATIONS          4

NUMBER OF VARIABLES             6

KENDALL COEFFICIENT=         .893


ORDER ANALYSIS FOR GROUP   4 OF
SAMPLE PROBLEM
FOR VARIABLE  1 THROUGH VARIABLE  6 OF DATA SET  1

VARIABLES ORDERED AS FOLLOWS

VARIABLE      RANK
     1          6
     2          5
     3          4
     4          2
     5          1
     6          3
```



FACTOR 1 IS ON THE X-AXIS AND FACTOR 2 IS ON THE Y-AXIS
NUMBERS REPRESENT NUMBER OF INDIVIDUALS AT EACH POINT

POSITIVE EXTREME POSITION (A) ON FACTOR 1

VARIABLE	RANK
1	4
2	3
3	1
4	2
5	5
6	6

FACTOR SCORES FOR THIS RANKING

1.92 .97

NEGATIVE EXTREME POSITION (B) ON FACTOR 1

VARIABLE	RANK
1	3
2	4
3	6
4	5
5	2
6	1

FACTOR SCORES FOR THIS RANKING

-1.63 .37

POSITIVE EXTREME POSITION (C) ON FACTOR 2

VARIABLE	RANK
1	1
2	2
3	3
4	5
5	6
6	4

FACTOR SCORES FOR THIS RANKING

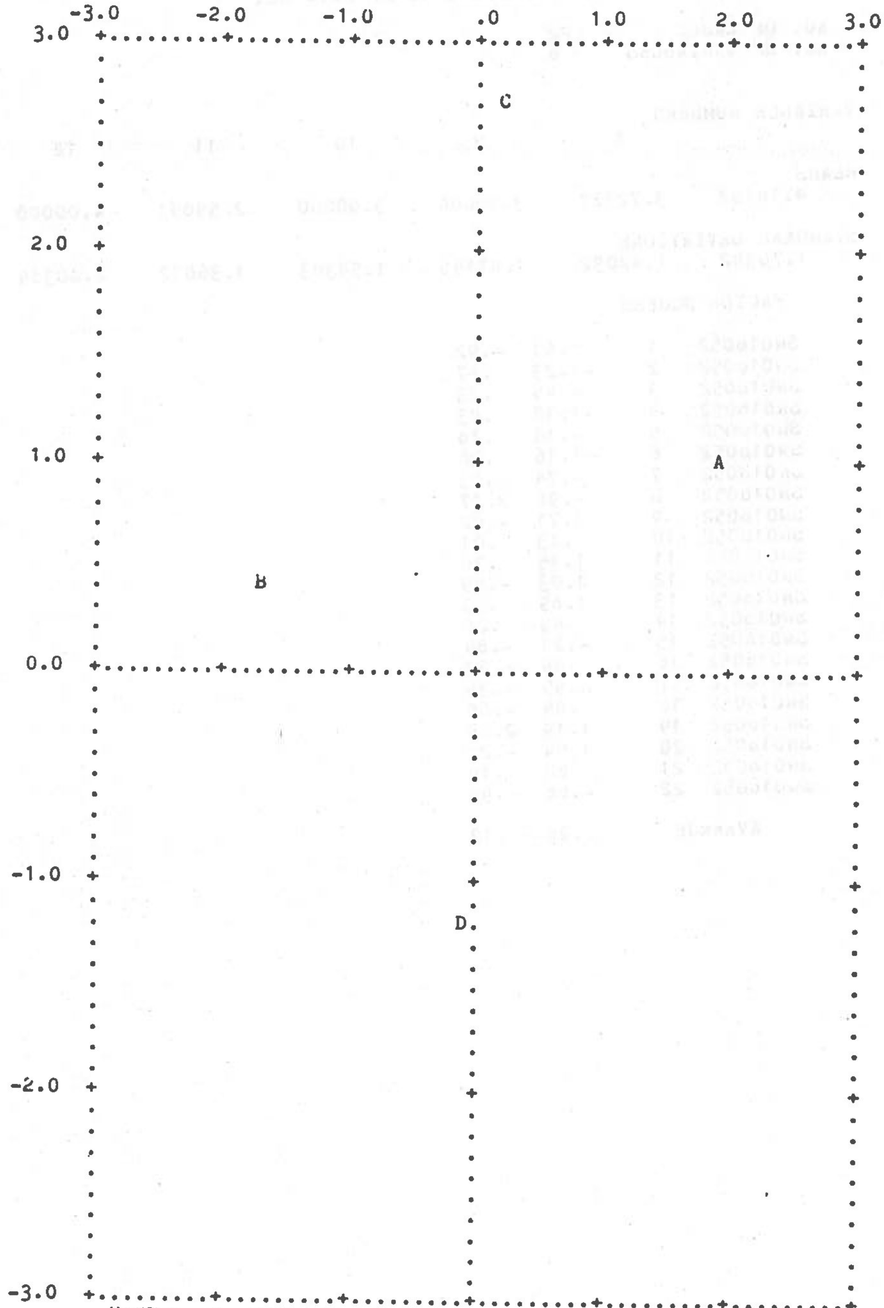
.29 2.63

NEGATIVE EXTREME POSITION (D) ON FACTOR 2

VARIABLE	RANK
1	6
2	5
3	4
4	2
5	1
6	3

FACTOR SCORES FOR THIS RANKING

-.00 -1.30



FACTOR 1 IS ON THE X-AXIS AND FACTOR 2 IS ON THE Y-AXIS
LETTERS REPRESENT EXTREME POSITIONS

F.

COMPARE ANALYSIS.....
SAMPLE PROBLEM
FOR VARIABLE 7 THROUGH VARIABLE 12 OF DATA SET 1

NO. OF CASES 22
NO. OF VARIABLES 6

VARIABLE NUMBERS	7	8	9	10	11	12
MEANS	4.18182	3.72727	3.50000	3.00000	2.59091	4.00000
STANDARD DEVIATIONS	1.76302	1.42032	1.47196	1.54303	1.36832	2.20389

FACTOR SCORES

SN018052	1	.61	-.92
SN018052	2	-1.23	.47
SN018052	3	-.45	.23
SN018052	4	-1.38	.43
SN018052	5	-.15	.18
SN018052	6	-1.16	.98
SN018052	7	-.74	-.73
SN018052	8	-.96	2.17
SN018052	9	1.71	-.02
SN018052	10	.13	.01
SN018052	11	1.45	.36
SN018052	12	1.03	-.89
SN018052	13	1.69	.50
SN018052	14	.49	.26
SN018052	15	-.21	-.84
SN018052	16	.24	-.33
SN018052	17	.95	-.38
SN018052	18	.84	-.65
SN018052	19	1.19	2.04
SN018052	20	1.59	-.29
SN018052	21	.80	1.19
SN018052	22	-.68	-.95
AVERAGE		.26	.13

IDENTIFICATION OF INDIVIDUALS WITHIN GROUPS

INDIVIDUALS CLOSEST TO AVERAGE

SN018052	10	.134
SN018052	5	.233
SN018052	16	.407
SN018052	3	.509
SN018052	14	.557
AVERAGE =		.368

KENDALL CONCORDANCE COEFFICIENT FOR THE AVERAGE GROUP OF
SAMPLE PROBLEM
FOR VARIABLE 7 THROUGH VARIABLE 12 OF DATA SET 1

NUMBER OF OBSERVATIONS 5

NUMBER OF VARIABLES 6

KENDALL COEFFICIENT= .342

ORDER ANALYSIS FOR THE AVERAGE GROUP OF
SAMPLE PROBLEM
FOR VARIABLE 7 THROUGH VARIABLE 12 OF DATA SET 1

VARIABLES ORDERED AS FOLLOWS

VARIABLE	RANK
7	5
8	3
9	4
10	2
11	1
12	6

GROUP 1--POSITIVE ON FACTOR 1

SN018052	9	1.705
SN018052	13	1.690
SN018052	20	1.595
SN018052	11	1.453
SN018052	12	1.031
SN018052	17	.950
SN018052	18	.839
AVERAGE =		1.323

KENDALL CONCORDANCE COEFFICIENT FOR GROUP 1 OF
SAMPLE PROBLEM
FOR VARIABLE 7 THROUGH VARIABLE 12 OF DATA SET 1

NUMBER OF OBSERVATIONS 7

NUMBER OF VARIALLES 6

KENDALL COEFFICIENT= .767

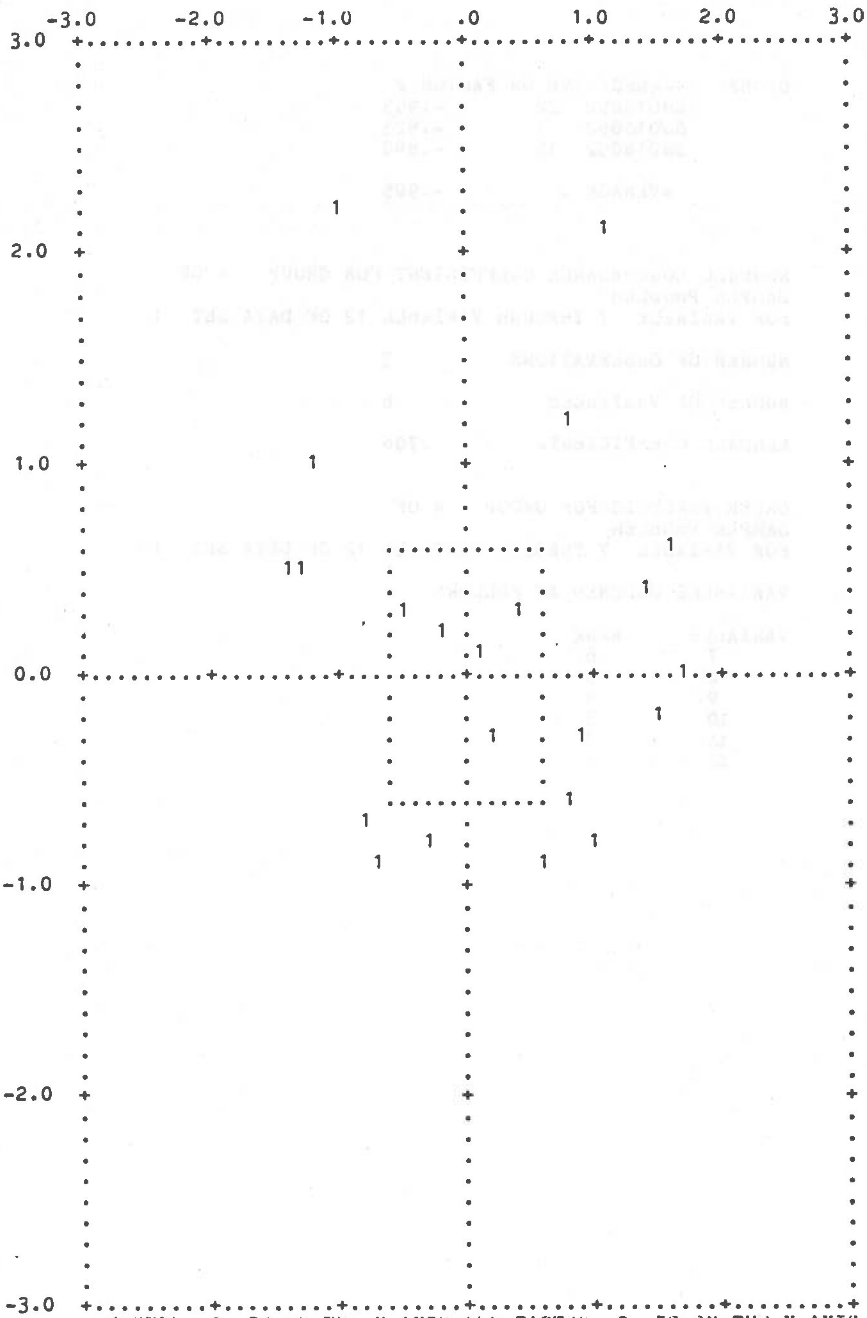
ORDER ANALYSIS FOR GROUP 1 OF
SAMPLE PROBLEM
FOR VARIABLE 7 THROUGH VARIABLE 12 OF DATA SET 1

VARIABLES ORDERED AS FOLLOWS

VARIABLE	RANK
7	5
8	4
9	2
10	1
11	3
12	6

```
GROUP    2--NEGATIVE ON FACTOR 1
         SN018052  4      -1.383
         SN018052  2      -1.228
         SN018052  6      -1.163
         SN018052  7       -.742

          AVERAGE =       -1.129


KENDALL CONCORDANCE COEFFICIENT FOR GROUP   2 OF
SAMPLE PROBLEM
FOR VARIABLE  7 THROUGH VARIABLE 12 OF DATA SET  1

NUMBER OF OBSERVATIONS          4

NUMBER OF VARIABLES             6

KENDALL COEFFICIENT=         .686

ORDER ANALYSIS FOR GROUP   2 OF
SAMPLE PROBLEM
FOR VARIABLE  7 THROUGH VARIABLE 12 OF DATA SET  1

VARIABLES ORDERED AS FOLLOWS

VARIABLE       RANK
    7            3
    8            5
    9            4
   10            6
   11            2
   12            1


GROUP    3--POSITIVE ON FACTOR 2
         SN018052   8      2.173
         SN018052  19      2.035
         SN018052  21      1.189

          AVERAGE =        1.799

KENDALL CONCORDANCE COEFFICIENT FOR GROUP   3 OF
SAMPLE PROBLEM
FOR VARIABLE  7 THROUGH VARIABLE 12 OF DATA SET  1

NUMBER OF OBSERVATIONS          3

NUMBER OF VARIABLES             6

KENDALL COEFFICIENT=         .454

ORDER ANALYSIS FOR GROUP   3 OF
SAMPLE PROBLEM
FOR VARIABLE  7 THROUGH VARIABLE 12 OF DATA SET  1

VARIABLES ORDERED AS FOLLOWS

VARIABLE       RANK
    7            3
    8            1
    9            2
   10            6
   11            5
   12            4
```

```
GROUP   4--NEGATIVE ON FACTOR 2
        SN018052  22        -.953
        SN018052   1        -.923
        SN018052  15        -.840

         AVERAGE =          -.905


KENDALL CONCORDANCE COEFFICIENT FOR GROUP   4 OF
SAMPLE PROBLEM
FOR VARIABLE  7 THROUGH VARIABLE 12 OF DATA SET  1

NUMBER OF OBSERVATIONS            3

NUMBER OF VARIABLES               6

KENDALL COEFFICIENT=           .708


ORDER ANALYSIS FOR GROUP   4 OF
SAMPLE PROBLEM
FOR VARIABLE  7 THROUGH VARIABLE 12 OF DATA SET  1

VARIABLES ORDERED AS FOLLOWS

VARIABLE      RANK
     7          6
     8          5
     9          4
    10          3
    11          1
    12          2
```



FACTOR 1 IS ON THE X-AXIS AND FACTOR 2 IS ON THE Y-AXIS
NUMBERS REPRESENT NUMBER OF INDIVIDUALS AT EACH POINT

G.

```
        LEVEL ANALYSIS FOR
SAMPLE PROBLEM
        FOR THE 13TH VARIABLE OF DATA SET  1

             MEAN                          1.91

             VARIANCE                      2.18

             STANDARD DEVIATION            1.48

             STANDARD ERROR                 .31

             SKEWNESS                     10.71

             KURTOSIS                     -2.76

             MODE                          1.00

             MEDIAN                        1.00

             RANGE                         4.00

             MINIMUM                       1.00

             MAXIMUM                       5.00


(PERCENTAGES REPRESENTED ABOVE THE INDIVIDUAL BARS)


     I  63.6
 1.00I\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
     I  13.6
 2.00I\\\\\\\\\\\\\\
     I   4.5
 3.00I\\\\
     I   4.5
 4.00I\\\\
     I  13.6
 5.00I\\\\\\\\\\\\\\
```

H.

```
        LEVEL ANALYSIS FOR
SAMPLE PROBLEM
        FOR THE 14TH VARIABLE OF DATA SET  1

             MEAN                          1.95

             VARIANCE                      1.28

             STANDARD DEVIATION            1.13

             STANDARD ERROR                 .24

             SKEWNESS                     15.62

             KURTOSIS                     -8.60

             MODE                          1.00

             MEDIAN                        2.00

             RANGE                         4.00

             MINIMUM                       1.00

             MAXIMUM                       5.00


(PERCENTAGES REPRESENTED ABOVE THE INDIVIDUAL BARS)


     I  50.0
 1.00I\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
     I  13.6
 2.00I\\\\\\\\\\\\\\\\\\\
     I  31.8
 3.00I\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
     I   4.5
 5.00I\\\\\
```

I.

```
          LEVEL ANALYSIS FOR
SAMPLE PROBLEM
          FOR THE 15TH VARIABLE OF DATA SET  1

               MEAN                    1.73

               VARIANCE                 .87

               STANDARD DEVIATION       .94

               STANDARD ERROR           .20

               SKEWNESS               17.45

               KURTOSIS              -11.70

               MODE                    1.00

               MEDIAN                  1.00

               RANGE                   3.00

               MINIMUM                 1.00

               MAXIMUM                 4.00


(PERCENTAGES REPRESENTED ABOVE THE INDIVIDUAL BARS)

     I  54.5
 1.00I\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
     I  22.7
 2.00I\\\\\\\\\\\\\\\\\\\\
     I  18.2
 3.00I\\\\\\\\\\\\\\\\
     I   4.5
 4.00I\\\\
```

J.

```
          LEVEL ANALYSIS FOR
SAMPLE PROBLEM
          FOR THE 17TH VARIABLE OF DATA SET  1

               MEAN                    2.86

               VARIANCE                2.50

               STANDARD DEVIATION      1.58

               STANDARD ERROR           .34

               SKEWNESS               16.16

               KURTOSIS              -11.89

               MODE                    1.00

               MEDIAN                  3.00

               RANGE                   4.00

               MINIMUM                 1.00

               MAXIMUM                 5.00


(PERCENTAGES REPRESENTED ABOVE THE INDIVIDUAL BARS)

     I  27.3
 1.00I\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
     I  22.7
 2.00I\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
     I   9.1
 3.00I\\\\\\\\\\\\\\\\
     I  18.2
 4.00I\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
     I  22.7
 5.00I\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
```

K. DATA SET 2 (FIRST 60 OBSERVATIONS) FOR SAMPLE PROBLEM

AN01USFS	1	6.	2.	5.	3.	4.	1.
AN01SCS	2	6.	4.	5.	2.	3.	1.
AN010SIS	3	4.	6.	3.	5.	1.	2.
AN01FBI	4	6.	2.	5.	4.	3.	1.
AN01CIA	5	6.	5.	4.	3.	2.	1.

L. COMPARE ANALYSIS.....
SAMPLE PROBLEM
FOR VARIABLE 1 THROUGH VARIABLE 6 OF DATA SET 2

NO. OF CASES 5
NO. OF VARIABLES 6

VARIABLE NUMBERS

	1	2	3	4	5	6
MEANS	5.60000	3.80000	4.40000	3.40000	2.60000	1.20000
STANDARD DEVIATIONS	.89443	1.78885	.89443	1.14018	1.14018	.44721

FACTOR SCORES

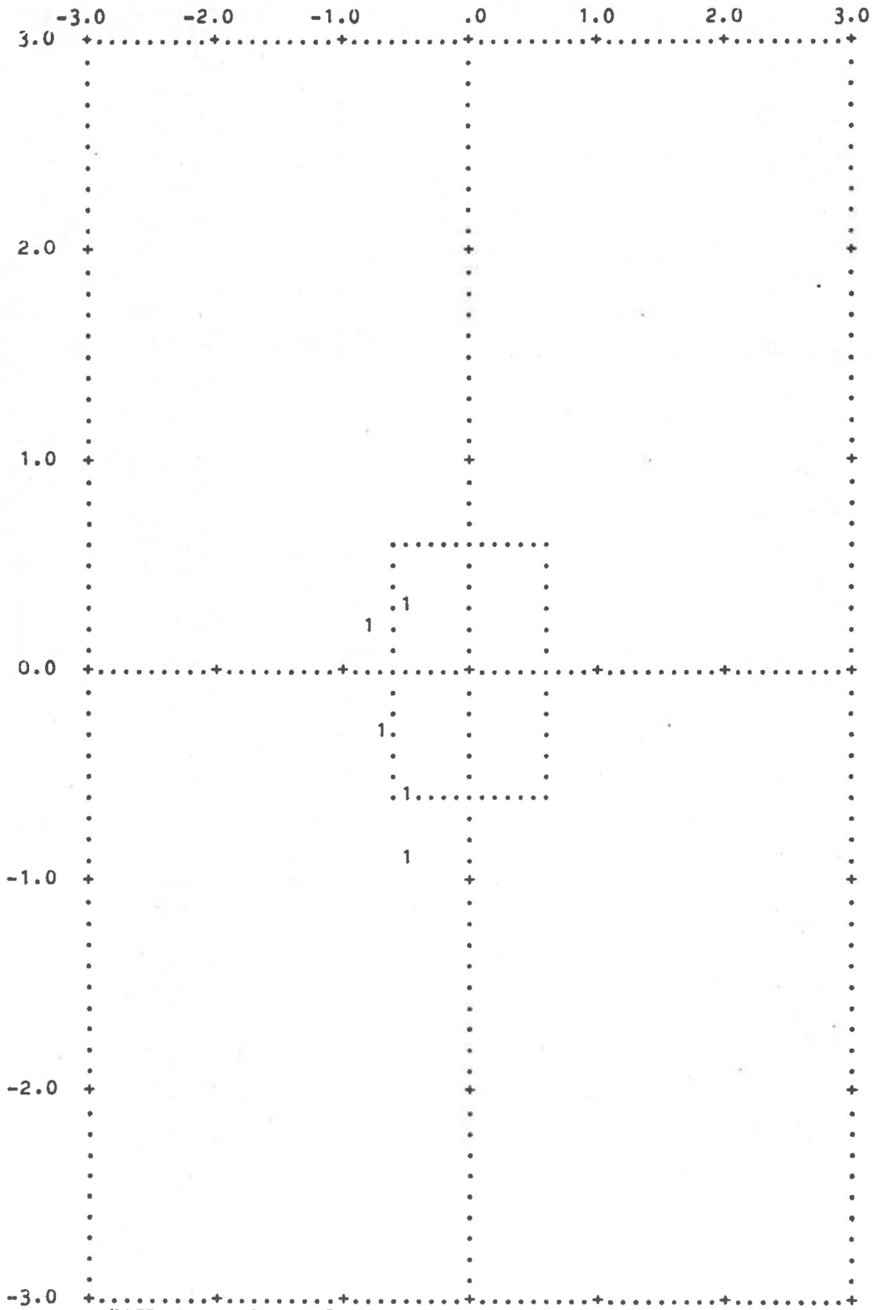
AN01USFS	1	-.45	.23
AN01SCS	2	-.42	-.69
AN010SIS	3	-.62	-.37
AN01FBI	4	-.77	.19
AN01CIA	5	-.46	-.90
AVERAGE		-.54	-.31

IDENTIFICATION OF INDIVIDUALS WITHIN GROUPS

INDIVIDUALS CLOSEST TO AVERAGE

AN01USFS 1 .509

```
GROUP    1--POSITIVE ON FACTOR 1


GROUP    2--NEGATIVE ON FACTOR 1
         AN01FB1      4          -.774
         AN01OSIS     3          -.617

          AVERAGE =              -.696


KENDALL CONCORDANCE COEFFICIENT FOR GROUP    2 OF
SAMPLE PROBLEM
FOR VARIABLE   1 THROUGH VARIABLE   6 OF DATA SET  2

NUMBER OF OBSERVATIONS           2

NUMBER OF VARIABLES              6

KENDALL COEFFICIENT=          .571

ORDER ANALYSIS FOR GROUP    2 OF
SAMPLE PROBLEM
FOR VARIABLE   1 THROUGH VARIABLE   6 OF DATA SET  2

VARIABLES ORDERED AS FOLLOWS

VARIABLE       RANK
     1           6
     2           5
     3           4
     4           3
     5           1
     6           2


GROUP    3--POSITIVE ON FACTOR 2


GROUP    4--NEGATIVE ON FACTOR 2
         AN01CIA      5          -.900
         AN01SCS      2          -.691

          AVERAGE =              -.795


KENDALL CONCORDANCE COEFFICIENT FOR GROUP    4 OF
SAMPLE PROBLEM
FOR VARIABLE   1 THROUGH VARIABLE   6 OF DATA SET  2

NUMBER OF OBSERVATIONS           2

NUMBER OF VARIABLES              6

KENDALL COEFFICIENT=          .943

ORDER ANALYSIS FOR GROUP    4 OF
SAMPLE PROBLEM
FOR VARIABLE   1 THROUGH VARIABLE   6 OF DATA SET  2

VARIABLES ORDERED AS FOLLOWS

VARIABLE       RANK
     1           6
     2           5
     3           4
     4           2
     5           3
     6           1
```



FACTOR 1 IS ON THE X-AXIS AND FACTOR 2 IS ON THE Y-AXIS
NUMBERS REPRESENT NUMBER OF INDIVIDUALS AT EACH POINT

M.

KENDALL CONCORDANCE COEFFICIENT FOR
SAMPLE PROBLEM
FOR VARIABLE 1 THROUGH VARIABLE 6 OF DATA SET 2

NUMBER OF OBSERVATIONS 5

NUMBER OF VARIABLES 6

KENDALL COEFFICIENT= .653

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APPENDIX A

Sample Questionnaire for Optical Mark Reader

H

ANSWER SHEET

NOTE: THIS ANSWER SHEET WILL BE SCORED WITH AN OPTICAL MARK READER. FILL IN ONE SPOT PER ROW WITH A SOFT BLACK PENCIL ONLY (NO. 2 OR NO. 2 1/2). FILL IN THE SPOT COMPLETELY. IF YOU CHANGE YOUR MIND, ERASE CLEANLY.

1. INDICATE YOUR VIEWS OF NATURAL RESOURCE PRIORITIES. MARK PRIORITIES FOR ITEMS INDICATING ONLY ONE PRIORITY PER ROW AND A DIFFERENT PRIORITY FOR EACH ROW.

	PRIORITY					
	1	2	3	4	5	6
RANGE MANAGEMENT.......	0	0	0	0	0	0
TIMBER MANAGEMENT......	0	0	0	0	0	0
DEVELOPED RECREATION...	0	0	0	0	0	0
SCENIC BEAUTY..........	0	0	0	0	0	0
WILDERNESS.............	0	0	0	0	0	0
WILDLIFE MANAGEMENT....	0	0	0	0	0	0

2. INDICATE YOUR VIEWS OF HOW THE REGIONAL AGENCIES SET PRIORITIES. MARK ONLY ONE PRIORITY PER ROW AND A DIFFERENT PRIORITY FOR EACH ROW.

	PRIORITY					
	1	2	3	4	5	6
RANGE MANAGEMENT.......	0	0	0	0	0	0
TIMBER MANAGEMENT......	0	0	0	0	0	0
DEVELOPED RECREATION...	0	0	0	0	0	0
SCENIC BEAUTY..........	0	0	0	0	0	0
WILDERNESS.............	0	0	0	0	0	0
WILDLIFE MANAGEMENT....	0	0	0	0	0	0

3. INDICATE YOUR PARTICIPATION IN, OR ORGANIZATION MEMBERSHIP RELATED TO, EACH OF THE NATURAL RESOURCE ITEMS. MAKE ONLY ONE MARK PER ROW.

	VERY FREQUENT	FREQUENT	OCCASIONAL	SELDOM	NEVER
RANGE MANAGEMENT.....	0	0	0	0	0
TIMBER MANAGEMENT....	0	0	0	0	0
DEVELOPED RECREATION.	0	0	0	0	0
SCENIC BEAUTY........	0	0	0	0	0
WILDERNESS...........	0	0	0	0	0
WILDLIFE MANAGEMENT..	0	0	0	0	0

SURVEY NUMBER SN01 ZIP CODE 8052 (FIRST FOUR DIGITS ONLY)
PLACE THIS ANSWER SHEET IN THE ENCLOSED ENVELOPE AND MAIL.

APPENDIX B

RANSAM Program Listing

```
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C                                                                       C
C                                                                       C
C      XX    XX    XX    XX    XX    XX    XX    XX    XX    XX    XX    XX    C
C       XX  XX      XX  XX      XX  XX      XX  XX      XX  XX      XX  XX     C
C        XXXX        XXXX        XXXX        XXXX        XXXX        XXXX      C
C     XXXXXXXXXX  XXXXXXXXXX  XXXXXXXXXX  XXXXXXXXXX  XXXXXXXXXX  XXXXXXXXXX   C
C     XXXXXXXXXX  XXXXXXXXXX  XXXXXXXXXX  XXXXXXXXXX  XXXXXXXXXX  XXXXXXXXXX   C
C        XXXX        XXXX        XXXX        XXXX        XXXX        XXXX      C
C       XX  XX      XX  XX      XX  XX      XX  XX      XX  XX      XX  XX     C
C      XX    XX    XX    XX    XX    XX    XX    XX    XX    XX    XX    XX    C
C                                                                       C
C                                                                       C
C     XXXXXXXXX    XXXXXXXX   XX      XX   XXXXXXXX    XXXXXXXX   XX      XX   C
C     XXXXXXXXXX  XXXXXXXXXX  XXX     XX  XXXXXXXXXX  XXXXXXXXXX  XXX    XXX   C
C     XX      XX  XX      XX  XXX     XX  XX          XX      XX  XXXX  XXXX   C
C     XX      XX  XX      XX  XX X    XX  XX          XX      XX  XX XXXX XX   C
C     XX      XX  XX      XX  XX XX   XX  XX          XX      XX  XX  XX  XX   C
C     XXXXXXXXXX  XXXXXXXXXX  XX  X   XX  XXXXXXXXX   XXXXXXXXXX  XX      XX   C
C     XXXXXXXXX   XXXXXXXXXX  XX  X   XX   XXXXXXXXX  XXXXXXXXXX  XX      XX   C
C     XX  XX      XX      XX  XX   X  XX          XX  XX      XX  XX      XX   C
C     XX   XX     XX      XX  XX   XX XX          XX  XX      XX  XX      XX   C
C     XX    XX    XX      XX  XX    XXXX          XX  XX      XX  XX      XX   C
C     XX     XX   XX      XX  XX     XXXX XXXXXXXXXX  XX      XX  XX      XX   C
C     XX      XX  XX      XX  XX      XXX  XXXXXXXX   XX      XX  XX      XX   C
C                                                                       C
C                                                                       C
C      XX    XX    XX    XX    XX    XX    XX    XX    XX    XX    XX    XX    C
C       XX  XX      XX  XX      XX  XX      XX  XX      XX  XX      XX  XX     C
C        XXXX        XXXX        XXXX        XXXX        XXXX        XXXX      C
C     XXXXXXXXXX  XXXXXXXXXX  XXXXXXXXXX  XXXXXXXXXX  XXXXXXXXXX  XXXXXXXXXX   C
C     XXXXXXXXXX  XXXXXXXXXX  XXXXXXXXXX  XXXXXXXXXX  XXXXXXXXXX  XXXXXXXXXX   C
C        XXXX        XXXX        XXXX        XXXX        XXXX        XXXX      C
C       XX  XX      XX  XX      XX  XX      XX  XX      XX  XX      XX  XX     C
C      XX    XX    XX    XX    XX    XX    XX    XX    XX    XX    XX    XX    C
C                                                                       C
C                                                                       C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C                                                                       C
C          THIS PROGRAM WAS WRITTEN BY DONALD A. JAMESON.               C
C                                                                       C
C              ****************************************                 C
C                                                                       C
C          PURPOSE-   TO SELECT RANDOM OBSERVATIONS FROM A STANDARD     C
C      3 COLUMN 100 ROW TELEPHONE BOOK.                                 C
C                                                                       C
C              ****************************************                 C
C                                                                       C
C          PROGRAM UNITS-    (MAIN PROGRAM) - RANSAM                    C
C      (CONTROL DATA UTILITY FUNCTION) - RANF                           C
C          RANF IS A RANDOM NUMBER GENERATOR WHICH RETURNS VALUES       C
C      UNIFORMLY DISTRIBUTED OVER THE INTERVAL BETWEEN ZERO AND ONE,    C
C      INCLUDING ZERO BUT NOT INCLUDING ONE.  THE ARGUMENT IS JUST      C
C      A DUMMY WHICH ENDS UP BEING IGNORED.                             C
C                                                                       C
C              ****************************************                 C
C                                                                       C
C          VARIABLE DEFINITIONS-                                        C
C                                                                       C
C      INDX     - INTEGER ARRAY CONTAINING ALL 600 CELLS OF A FACING    C
C                 PAGE.                                                 C
C      IOUT     - INTEGER ARRAY CONTAINING SELECTED CELLS.              C
C      IR       - INTEGER VARIABLE CONTAINING A RANDOM VALUE 1-100.     C
```

```
C        JA       - INTEGER VARIABLE CONTAINING STARTING COLUMN.                 C
C                   USUALLY 1, BUT 4 FOR PAGE 1.                                 C
C        JB       - INTEGER VARIABLE CONTAINING ENDING COLUMN, USUALLY 6,        C
C                   BUT 3 FOR THE LAST PAGE IF EVEN.                             C
C        KOUNT    - INTEGER ARRAY CONTAINING NUMBER OF OBSERVATIONS              C
C                   PER COLUMN.                                                  C
C        MAX      - INTEGER VARIABLE CONTAINING MAXIMUM NUMBER OF                C
C                   OBSERVATIONS IN A COLUMN.                                    C
C        NADD     - INTEGER VARIABLE CONTAINING THE VALUE FOR ADDITION           C
C                   OF ONE PAGE AT FIRST AND END OF BOOK.                        C
C        NFP      - INTEGER VARIABLE CONTAINING NUMBER OF FACING PAGES.          C
C        NP       - INTEGER VARIBLE CONTAINING NUMBER OF ENDING PAGE.            C
C        NPG      - INTEGER COUNTER FOR PAGE NUMBERS.                            C
C        NS       - INTEGER VARIABLE CONTAINING NUMBER OF OBSERVATIONS.          C
C        NSPF     - INTEGER VARIABLE CONTAINING NUMBER OF OBSERVATIONS           C
C                   PER FACING PAGE.                                             C
C        NT       - INTEGER VARIABLE CONTAINING NFP*2 TO CHECK FOR EVEN/         C
C                   ODD PAGES.                                                   C
C        NZ       - INTEGER VARIABLE CONTAINING NUMBER OF STARTING PAGE.         C
C        R        - REAL VARIABLE CONTAINING A RANDOM VALUE 0-1.0.               C
C        TITLE    - INTEGER ARRAY CONTAINING A 62 CHARACTER ALPHANUMERIC         C
C                   TITLE.                                                       C
C                                                                                C
C                  ****************************************                      C
C                                                                                C
C             PROGRAM FILES-   TAPE5 REFERENCED BY THE VARIABLE (READU)          C
C        IS EQUIVALENCED TO THE INPUT FILE, IN THIS CASE THE CARD                C
C        READER.  TAPE6 REFERENCED BY THE VARIABLE (WRITEU) IS                   C
C        EQUIVALENCED TO THE OUTPUT FILE, IN THIS CASE THE LINE PRINTER.         C
C        THESE VARIABLES ARE INITIALIZED IN A DATA STATEMENT.                    C
C                                                                                C
C                  ****************************************                      C
C                                                                                C
C             FORMAT OF DATA ENTRIES-                                            C
C                                                                                C
C        CARD  1 - VARIOUS DATA ITEMS IN THE FOLLOWING COLUMNS-                  C
C                    1-5  = VALUE FOR NUMBER OF STARTING PAGE RIGHT              C
C                           JUSTIFIED IN THE FIELD.  FORMAT (I5).   -NZ-         C
C                    6-10 = VALUE FOR NUMBER OF ENDING PAGE RIGHT                C
C                           JUSTIFIED IN THE FIELD.  FORMAT (I5).   -NP-         C
C                   11-15 = VALUE FOR NUMBER OF OBSERVATIONS RIGHT               C
C                           JUSTIFIED IN THE FIELD.  FORMAT (I5).   -NS-         C
C                   16-77 = PROBLEM DESCRIPTION.  FORMAT (31A2).  -TITLE-        C
C        CARD  2 - BLANK CARD FOR PROGRAM STOP SIGNAL.                           C
C                                                                                C
C                  ****************************************                      C
C                                                                                C
C             REMARKS-   ALL CODING WITHIN THIS PROGRAM HAS BEEN                 C
C        CONFORMED TO STANDARD ANSI FORTRAN EXCEPT THE FOLLOWING ITEMS,          C
C        THE PROGRAM CARD WHICH IS A PART OF CDC SCOPE 3.3 OPERATING             C
C        SYSTEM, AND CDC UTILITY FUNCTION.  THE FUNCTION (RANF) IS               C
C        REFERENCED IN THE PROGRAM (RANSAM) LINE 46.                             C
C                                                                                C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C                                                                         RNSAM001
      INTEGER I, IK, INDX(100,6), IOUT(100,6), IR, J, JA, JB, K, KCOL     RNSAM002
      INTEGER KOUNT(6), L, MAX, NADD, NFP, NP, NPG, NS, NSPF, NT, NW, NZRNSAM003
      INTEGER READU, TITLE(31), WRITEU                                    RNSAM004
      REAL R                                                              RNSAM005
C                                                                         RNSAM006
      DATA READU/5/, WRITEU/6/,COL/3HCOL/,UMN/3HUMN/                      RNSAM007
C                                                                         RNSAM008
  101 READ (READU,117) NZ,NP,NS,(TITLE(L),L=1,31)                         RNSAM009
      IF (NP) 103,103,102                                                 RNSAM010
  102 IF (NS) 103,103,104                                                 RNSAM011
```

```
103 WRITE (WRITEU,118)
    STOP
C
C . . . . . . CALCULATE NUMBER OF FACING PAGES AND NUMBER OF
C        OBSERVATIONS PER FACING PAGE.
C
104 NFP=(NP-NZ+1)/2
    NT=NP/2
    NX=NZ/2
    NX=NX*2
    NW=NP-NZ+1
    NT=NT*2
    IF (NT.EQ.NP) NFP=NFP+1
    NADD=(NS/NW)/NW
    NSPF=(NS+NFP-1)/NFP
    IF (NT.EQ.NP.OR.NX.NE.NZ) NSPF=NSPF+NADD
    WRITE (WRITEU,116) (TITLE(L),L=1,31),NZ,NP,NS,NSPF
    IF (NSPF.GT.300) GO TO 105
    IF (NSPF.LT.1) GO TO 106
    GO TO 107
105 WRITE (WRITEU,119)
    GO TO 101
106 WRITE (WRITEU,120)
    GO TO 101
C
C . . . . . . CLEAR ARRAYS.
C
107 DO 108 I=1,100
    DO 108 J=1,6
        INDX(I,J)=0
        IOUT(I,J)=0
108 CONTINUE
C
C . . . . . . SELECT ROW NUMBER BY COLUMN.
C
    DO 115 NPG=NX,NT,2
        DO 111 K=1,NSPF
109         R=RANF(1.0)
            IR=R*600.0+1.0
            J=1+(IR-1)/100
            I=IR-(J-1)*100
            IF (INDX(I,J)) 110,110,109
110         INDX(I,J)=I
111     CONTINUE
C
C . . . . . . WRITE SELECTED ROW NUMBERS.
C
        MAX=0
        DO 113 J=1,6
            KOUNT(J)=0
        DO 113 I=1,100
            IF (INDX(I,J)) 113,113,112
112         KOUNT(J)=KOUNT(J)+1
            IF (KOUNT(J).GT.MAX) MAX=KOUNT(J)
            IK=KOUNT(J)
            IOUT(IK,J)=INDX(I,J)
            INDX(I,J)=0
113     CONTINUE
        DO 114 I=1,MAX
            JA=1
            IF (NX.NE.NZ.AND.NPG.EQ.NX) JA=4
            JB=6
            IF (NPG.GE.NT.AND.NT.EQ.NP) JB=3
            IF (I.EQ.1) WRITE (WRITEU,121) NPG,(COL,UMN,KCOL,KCOL=JA,JB)
114     WRITE (WRITEU,122) (IOUT(I,J),J=JA,JB)
    DO 115 I=1,MAX
```

```
      DO 115 J=1,6
         IOUT(I,J)=0
  115 CONTINUE
      WRITE (WRITEU,123)
      GO TO 101
C
C . . . . . . FORMATS USED IN THIS PROGRAM.
C
  116 FORMAT (1H1,31A2/,1H ,13HSTARTING PAGE,15X,I12,/,1H ,11HENDING PAG
     1E,17X,I12/1H ,23HNUMBER OF OBSERVATIONS ,12X,I5/1H ,33HNUMBER OF S
     2AMPLES PER FACING PAGE,I7)
  117 FORMAT (3I5,31A2)
  118 FORMAT (1H0,35H BLANK CARD INDICATES PROGRAM STOP )
  119 FORMAT (1H0,52H NUMBER OF SAMPLES GREATER THAN ONE-HALF OF ENTRIES
     1 ,/1H0,28H SUGGEST 100 PERCENT SAMPLE )
  120 FORMAT (1H0,49H NUMBER OF SAMPLES LESS THAN ONE PER DOUBLE PAGE ,/
     11H0,35H SUGGEST RANDOM SELECTION OF PAGES )
  121 FORMAT (1H0,//1H0,13H PAGE NUMBER ,I5/1H0,3X,6(4X,A3,A3,I2))
  122 FORMAT (1H ,6I12)
  123 FORMAT (1H0,/1H0)
C
      END
```

APPENDIX C

PUBLIC Program Listing

```
      PROGRAM PUBLIC                                                    PUBLC001
     1(INPUT,OUTPUT,TAPE1,TAPE2,TAPE3,TAPE4,TAPE5=INPUT,                PUBLC002
     2TAPE6=OUTPUT,TAPE7,TAPE8,TAPE9,PUNCH,TAPE10=PUNCH)                PUBLC003
C                                                                       PUBLC004
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C                                                                      C
C                                                                      C
C      XX    XX   XX    XX   XX    XX   XX    XX   XX    XX   XX    XX C
C       XX  XX     XX  XX     XX  XX     XX  XX     XX  XX     XX  XX  C
C        XXXX       XXXX       XXXX       XXXX       XXXX       XXXX   C
C     XXXXXXXXXX XXXXXXXXXX XXXXXXXXXX XXXXXXXXXX XXXXXXXXXX XXXXXXXXXX C
C     XXXXXXXXXX XXXXXXXXXX XXXXXXXXXX XXXXXXXXXX XXXXXXXXXX XXXXXXXXXX C
C        XXXX       XXXX       XXXX       XXXX       XXXX       XXXX   C
C       XX  XX     XX  XX     XX  XX     XX  XX     XX  XX     XX  XX  C
C      XX    XX   XX    XX   XX    XX   XX    XX   XX    XX   XX    XX C
C                                                                      C
C                                                                      C
C     XXXXXXXXX  XX      XX XXXXXXXXX  XX         XXXXXXXXXX  XXXXXXXX  C
C     XXXXXXXXXX XX      XX XXXXXXXXXX XX         XXXXXXXXXX XXXXXXXXXX C
C     XX      XX XX      XX XX      XX XX             XX     XX      XX C
C     XX      XX XX      XX XX      XX XX             XX     XX         C
C     XX      XX XX      XX XX      XX XX             XX     XX         C
C     XXXXXXXXXX XX      XX XXXXXXXXX  XX             XX     XX         C
C     XXXXXXXXX  XX      XX XXXXXXXXX  XX             XX     XX         C
C     XX         XX      XX XX      XX XX             XX     XX         C
C     XX         XX      XX XX      XX XX             XX     XX         C
C     XX         XX      XX XX      XX XX             XX     XX      XX C
C     XX         XXXXXXXXXX XXXXXXXXXX XXXXXXXXXX XXXXXXXXXX XXXXXXXXXX C
C     XX          XXXXXXXX  XXXXXXXXX  XXXXXXXXXX XXXXXXXXXX  XXXXXXXX  C
C                                                                      C
C                                                                      C
C      XX    XX   XX    XX   XX    XX   XX    XX   XX    XX   XX    XX C
C       XX  XX     XX  XX     XX  XX     XX  XX     XX  XX     XX  XX  C
C        XXXX       XXXX       XXXX       XXXX       XXXX       XXXX   C
C     XXXXXXXXXX XXXXXXXXXX XXXXXXXXXX XXXXXXXXXX XXXXXXXXXX XXXXXXXXXX C
C     XXXXXXXXXX XXXXXXXXXX XXXXXXXXXX XXXXXXXXXX XXXXXXXXXX XXXXXXXXXX C
C        XXXX       XXXX       XXXX       XXXX       XXXX       XXXX   C
C       XX  XX     XX  XX     XX  XX     XX  XX     XX  XX     XX  XX  C
C      XX    XX   XX    XX   XX    XX   XX    XX   XX    XX   XX    XX C
C                                                                      C
C                                                                      C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C                                                                      C
C            THIS PROGRAM WAS DEVELOPED BY SEVERAL PEOPLE OVER A PERIOD C
C       OF THREE YEARS, AND IN ADDITION INCORPORATES VARIATIONS OF     C
C       PROGRAMS FROM UCLA BIOMEDICAL DIVISION STATISTICAL ROUTINES    C
C       (BMD) AND IBM SCIENTIFIC SUBROUTINE PACKAGE (SSP) AND          C
C       STATISTICAL PACKAGE FOR THE SOCIAL SCIENCES (SPSS).  THE       C
C       STATISTICAL PACKAGE (LEVEL) WAS ADAPTED BY R. D. CHILD,        C
C       PAMELA CASE, AND LINDA ROLLIN.  KENDALL]S CONCORDANCE          C
C       COEFFICIENT (KENDAL) WAS DEVELOPED BY R. D. CHILD AND          C
C       FOLLOWS THE FORMULA FOR KENDALL]S W.  THE SINGLE PREFERENCE    C
C       ORDER FROM RANK DATA (ORDER) WAS SUGGESTED BY PAMELA CASE,     C
C       AND PROGRAMMED BY D. A. JAMESON.  THE FACTOR ANALYSIS          C
C       ANALYSIS SUBROUTINES WERE ADAPTED FROM THE BMD PACKAGE WITH    C
C       PLOTTING AND GROUPING ROUTINES DEVELOPED BY R. D. CHILD        C
C       AND D. A. JAMESON, AND WITH THE EXTREME ANALYSIS ROUTINE       C
C       DEVELOPED BY LINDA ROLLIN.                                     C
C                                                                      C
C                ******************************************            C
C                                                                      C
```

```
C         PURPOSE-    TO ANALYZE DATA COLLECTED ON PUBLIC OPINIONS.          C
C     THE DATA CAN BE RANKED  (I.E. VARIABLES CAN TAKE VALUES ONE            C
C     THROUGH N INTEGERS, WHERE N IS THE NUMBER OF VARIABLES) OR             C
C     UNRANKED (I.E. VARIABLES CAN HAVE THE VALUE OF ANY REAL                C
C     NUMBER).  ANALYSES INCLUDE (1) BASIC STATISTICAL ANALYSES SUCH         C
C     AS MEAN, STANDARD DEVIATIONS, KUROSIS, AND SKEWNESS# (2)               C
C     KENDALL]S CONCORDANCE COEFFICIENT# (3) PREFERENCE ORDERING# AND        C
C     (4) FACTOR ANALYSIS.  THESE ROUTINES PROVIDE ANALYSES OF               C
C     OPINION DATA IN A FORMAT USEFUL FOR MANAGERIAL ACTION.                 C
C                                                                            C
C               ****************************************                     C
C                                                                            C
C         PROGRAM UNITS-    (MAIN PROGRAM) - PUBLIC                          C
C     (SUBPROGRAM) - BLOCK DATA                                              C
C     (SUBROUTINES) - CORRE, DATCK, EIGEN, EXTRM, FACTOR, FSCOR              C
C                     GROUP, GRUPN, HIST, KENDAL, LEVEL, LOAD                C
C                     MATINV, ORDER, PLOT, SORT, SORT1, SYMB, VARMX          C
C     (INTRINSIC ANSI FUNCTIONS) - ABS, FLOAT, IFIX, INT                     C
C     (EXTERNAL ANSI FUNCTIONS) - SQRT                                       C
C         ABS FINDS THE ABSOLUTE VALUE OF A REAL ARGUMENT.                   C
C         FLOAT IS A CONVERSION PROCESS GIVEN AN INTEGER ARGUMENT            C
C     TO A REAL VARIABLE.                                                    C
C         IFIX IS A CONVERSION PROCESS GIVEN A REAL ARGUMENT TO              C
C     AN INTEGER VARIABLE WITH TRUNCATION.                                   C
C         INT IS A FUNCTION THAT TRUNCATES THE VALUE OF A REAL               C
C     VARIABLE TO BECOME AN INTEGER VARIABLE.                                C
C         SQRT CALCULATES THE SQUARE ROOT OF ITS REAL ARGUMENT.              C
C                                                                            C
C               ****************************************                     C
C                                                                            C
C         VARIABLE DEFINITIONS-    SOME VARIABLES IN THE SUBROUTINES         C
C     (EIGEN, MATINV, AND VARMX) ARE NOT DEFINED OTHERWISE ALL               C
C     VARIABLES EXCEPT SUBSCRIPTS ARE DEFINED BELOW.                         C
C     A        - REAL ARRAY CONTAINING THE FACTOR MATRIX TO BE ROTATED       C
C                IN THE SUBROUTINE (VARMX).                                  C
C     A        - REAL ARRAY CONTAINING THE RESULTANT EIGENVALUES             C
C                DEVELOPED ON THE DIAGONAL IN DESCENDING ORDER IN THE        C
C                SUBROUTINE (EIGEN).                                         C
C     A        - REAL MATRIX CONTAINING THE SQUARE MATRIX TO BE              C
C                INVERTED IN THE SUBROUTINE (MATINV).                        C
C     ANORM    - REAL VARIABLE CONTAINING THE INITIAL NORM.                  C
C     ANRMX    - REAL VARIABLE CONTAINING THE FINAL NORM.                    C
C     AVEFSC   - REAL ARRAY CONTAINING AN AVERAGE VALUE OF FACTOR            C
C                SCORES FOR EACH ROTATED FACTOR.                             C
C     AVG      - REAL VARIABLE CONTAINING THE AVERAGE VALUE FOR THE          C
C                FACTOR SCORES IN A PARTICULAR GROUP.                        C
C     B        - REAL ARRAY CONTAINING THE ORIGINAL COMMUNALITIES IN         C
C                THE SUBROUTINE (FACTOR).                                    C
C     B        - REAL ARRAY CONTAINING THE SUM OF OBSERVATIONS IN THE        C
C                SUBROUTINE (CORRE).                                         C
C     C        - REAL ARRAY CONTAINING THE SIZE OF THE CENTRAL CUBE,         C
C                DEPENDING ON THE NUMBER OF ROTATED FACTORS IN THE           C
C                SUBROUTINES (GROUP, AND PLOT) AND SUBPROGRAM                C
C                (BLOCK DATA).                                               C
C     C        - REAL MATRIX CONTAINING ROTATED FACTOR LOADINGS IN           C
C                SUBROUTINE (EXTRM).                                         C
C     C        - REAL MATRIX CONTAINING THE FACTOR MATRIX FOR FACTOR         C
C                ANALYSIS DATA AND SECONDLY RAW SCORE WEIGHTS IN THE         C
C                SUBROUTINE (FSCOR).                                         C
C     CATEGS   - REAL ARRAY CONTAINING THE PERCENTAGES OF FREQUENCY          C
C                FOR THE UNIQUE VALUES OCCURRING IN THE DATA SET.            C
C     CCNTRL   - INTEGER VARIABLE CONTAINING A CARRIAGE CONTROL VALUE        C
C                FOR EITHER PRINTING AT THE START OF A NEW PAGE (1) OR       C
C                DOUBLE SPACE FROM PREVIOUS PRINTING LINE (0).               C
C     CENT     - REAL VARIABLE CONTAINING THE SIZE OF THE CENTRAL CUBE       C
C                FOR GROUPING PROCESS.                                       C
C     CHISQ    - REAL VARIABLE CONTAINING THE STATISTICAL VALUE FOR          C
C                CHI-SQUARE.                                                 C
```

```
C       CORECT  - REAL VARIABLE CONTAINING CHECK VALUE FOR DATA VALUES      C
C                 INPUT INTO THE PROGRAM.                                   C
C       D       - REAL ARRAY CONTAINING THE DATA VALUES READ FROM THE       C
C                 DISK OR TAPE FOR FACTOR ANALYSIS DATA IN THE              C
C                 SUBROUTINE (CORRE).                                       C
C       D       - REAL ARRAY CONTAINING THE STORAGE FOR OUTPUT VALUES       C
C                 AND SECONDLY, THE DIFFERENCES FOR COMMUNALITIES IN        C
C                 THE SUBROUTINES (FACTOR AND VARMX).                       C
C       D       - REAL MATRIX CONTAINING THE FACTOR MATRIX WITH SQUARED     C
C                 VALUES IN THE SUBROUTINE (FSCOR).                         C
C       DATA    - REAL ARRAY CONTAINING STORAGE PLACE FOR DATA VALUES.      C
C       DATCNT  - INTEGER VARIABLE CONTAINING THE DATA SET NUMBER           C
C                 CURRENTLY BEING PROCESSED.                                C
C       DUM     - INTEGER VARIABLE CONTAINING TEMPORARY STORAGE FOR         C
C                 THE NUMBER OF VARIABLES.                                  C
C       EP      - REAL VARIABLE CONTAINING EXPONENT USED FOR                C
C                 CALCULATING SIZE OF CENTRAL CUBE IF NUMBER OF ROTATED     C
C                 FACTORS IS GREATER THAN NINE.                             C
C       EXTOP   - INTEGER VARIABLE CONTAINING THE OPTION FOR EXTREME        C
C                 ANALYSIS AS PART OF FACTOR ANALYSIS.                      C
C       F       - REAL ARRAY CONTAINING THE FINAL COMMUNALITIES IN THE      C
C                 SUBROUTINE (VARMX).                                       C
C       FC      - REAL MATRIX CONTAINING FACTOR SCORE COEFFICIENTS.         C
C       FL      - REAL MATRIX CONTAINING THE ROTATED FACTOR LOADINGS.       C
C       FMAX    - REAL VARIABLE CONTAINING CURRENT MAXIMUM VALUE OF         C
C                 FACTOR LOADINGS ON EACH FACTOR.                           C
C       FMT     - INTEGER ARRAY CONTAINING THE VARIABLE FORMAT.             C
C       FN      - A REAL VARIABLE CONTAINING THE NUMBER OF                  C
C                 OBSERVATIONS FOR FACTOR ANALYSIS DATA.                    C
C       H       - REAL ARRAY CONTAINING THE ORIGINAL COMMUNALITIES.         C
C       IALPHA  - INTEGER ARRAY CONTAINING THE ALPHABETIC SYMBOLS           C
C                 REPRESENTING VARIABLES.                                   C
C       ICON    - INTEGER VARIABLE CONTAINING THE NUMBER OF FACTORS TO      C
C                 BE ROTATED.                                               C
C       ID      - INTEGER ARRAY CONTAINING THE THREE IDENTIFICATION         C
C                 FIELDS FOR EITHER EACH OBSERVATION IN ALL                 C
C                 SUBROUTINES EXCEPT (GRUPN) OR EACH SET OF FACTOR          C
C                 SCORES IN THE SUBROUTINE (GRUPN).                         C
C       IDD     - INTEGER ARRAY CONTAINING THE IDENTIFICATION FIELDS        C
C                 FOR EACH OBSERVATIONS DATA VALUES IN THE SUBROUTINE       C
C                 (GRUPN).                                                  C
C       IDF     - INTEGER VARIABLE CONTAINING THE STATISTICAL VALUE FOR     C
C                 THE DEGREES OF FREEDOM.                                   C
C       IERR    - INTEGER VARIABLE CONTAINING A FLAG FOR BAD DATA NOT       C
C                 BEING PUT ONTO THE INPUT DISK FOR EACH ANALYSIS           C
C                 EXCEPT LEVEL.                                             C
C       IFAC    - INTEGER VARIABLE CONTAINING A ONE IN VALUE FOR            C
C                 COMPARISON ANALYSIS AND A ZERO FOR OTHER ANALYSES.        C
C       IFIRST  - INTEGER VARIABLE USED TO DETERMINE WHETHER POSITIVE       C
C                 OR NEGATIVE AXIS IS BEING ANALYZED.                       C
C       IFLAG   - INTEGER VARIABLE CONTAINING A FLAG TO INDICATE THAT       C
C                 BARS IN HISTOGRAM REPRESENT A RANGE OF VALUES.            C
C       IGZ     - INTEGER VARIABLE CONTAINING THE VALUE USED TO             C
C                 DETERMINE WHETHER THE CURRENT DOMINANT VECTOR IS          C
C                 POSITIVE OR NEGATIVE.                                     C
C       IND     - INTEGER VARIABLE CONTAINING THE INDICATOR FOR ANY         C
C                 OFF-DIAGONAL ELEMENTS GREATER THAN THRESHOLD.             C
C       INUM    - INTEGER ARRAY CONTAINING ALPHABETIC CHARACTERS            C
C                 FOR THE HEADING PRINTING FOR LEVEL ANALYSIS.              C
C       IOBJ    - INTEGER VARIABLE CONTAINING A FLAG TO SHOW OBJECTION      C
C                 TO CURRENT RANKING (1), OTHERWISE (0).                    C
C       IPRIN   - INTEGER VARIABLE CONTAINING THE FLAG VALUE FOR            C
C                 PRINTING AND/OR PUNCHING FACTOR SCORES OR NOT.            C
C       IRANK   - INTEGER ARRAY CONTAINING THE CURRENT RANKINGS FROM        C
C                 THE ORDER ANALYSIS DATA.                                  C
C       ISMKNT  - INTEGER VARIABLE CONTAINING THE SUM OF THE NUMBER OF      C
C                 OBSERVATIONS FOR EACH DISTINCT DATA VALUE.                C
C       ISORT   - INTEGER VARIABLE CONTAINING A VALUE FOR DIRECTING THE     C
```

```
C                SORTING PROCESS FOR ASCENDING ORDER (1) OR DESCENDING        C
C                ORDER (0).                                                   C
C       ISTORE - INTEGER VARIABLE CONTAINING A GROUP NUMBER FOR EACH          C
C                OBSERVATION WITHIN THE GROUPING PROCESS OF FACTOR AND        C
C                COMPARE ANALYSES.                                            C
C       ISYM   - INTEGER VARIABLE CONTAINING THE NUMBERS WHICH                C
C                REPRESENT THE TIMES A CERTAIN POINT ON THE PLOT IS           C
C                BEING REFERENCED.                                            C
C       ITOP   - INTEGER VARIABLE CONTAINING THE LARGEST VALUE FOR THE        C
C                NUMBER OF OBSERVATIONS FOR EACH DISTINCT DATA VALUE.         C
C       IWIDE  - INTEGER VARIABLE CONTAINING THE VALUE ONE IF OUTPUT          C
C                FILE HAS LESS THAN 120 CHARACTERS FOR A CARRIAGE             C
C                WIDTH AND A VALUE OF ZERO, OTHERWISE.                        C
C       IWORD  - INTEGER VARIABLE CONTAINING THE INPUT COMMAND WORDS.         C
C       IXTRM  - INTEGER ARRAY CONTAINING EXTREME RANKINGS.                   C
C       JFLAG  - INTEGER VARIABLE CONTAINING THE POSITION OF A DATA           C
C                ITEM IN THE RANKINGS ARRAY (IRANK).                          C
C       JGRP   - INTEGER VARIABLE CONTAINING THE GROUP NUMBER                 C
C                CURRENTLY BEING PROCESSED.                                   C
C       JH     - INTEGER VARIABLE CONTAINING THE CURRENT HIGHEST              C
C                UNASSIGNED RANK.                                             C
C       JHIGH  - INTEGER VARIABLE CONTAINING THE POSITION OF THE              C
C                HIGHEST UNASSIGNED VALUE IN THE ORDER ANALYSIS DATA.         C
C       JL     - INTEGER VARIABLE CONTAINING THE CURRENT LOWEST               C
C                UNASSIGNED RANK.                                             C
C       JLOW   - INTEGER VARIABLE CONTAINING THE POSITION OF THE              C
C                LOWEST UNASSIGNED VALUE IN THE ORDER ANALYSIS DATA.          C
C       K      - INTEGER VARIABLE CONTAINING THE NUMBER OF DISTINCT           C
C                VALUES FOR THE DATA IN THE SUBROUTINE (LEVEL).               C
C       K      - INTEGER VARIABLE CONTAINING THE NUMBER OF FACTORS            C
C                ROTATED IN THE SUBROUTINES (LOAD AND VARMX).                 C
C       K      - INTEGER VARIABLE CONTAINING THE NUMBER OF VALUES TO          C
C                BE SORTED IN THE SUBROUTINE (SORT1).                         C
C       K      - INTEGER VARIABLE CONTAINING THE TRUNCATED VALUE OF           C
C                THE VARIABLE (PCT) IN THE SUBROUTINE (HIST).                 C
C       KD     - INTEGER MATRIX CONTAINING THE THREE IDENTIFICATION           C
C                FIELDS FOR EACH SET OF FACTOR SCORES.                        C
C       KENCC  - REAL VARIABLE CONTAINING THE STATISTICAL VALUE FOR           C
C                THE KENDALL'S W COEFFICIENT OF CONCORDANCE.                  C
C       KF     - INTEGER VARIABLE CONTAINING THE CURRENT TYPE OF PLOT         C
C                REQUESTED.                                                   C
C       KHIGH  - INTEGER VARIABLE CONTAINING THE DATA VALUE WITH THE          C
C                HIGHEST NUMERICAL VALUE OF THE ORDER ANALYSIS DATA.          C
C       KK     - INTEGER VARIABLE CONTAINING TEMPORARY STORAGE FOR THE        C
C                NUMBER OF OBSERVATIONS OF WHOSE VALUES ARE BEING             C
C                SORTED.                                                      C
C       KKD    - INTEGER VARIABLE CONTAINING THE FIRST OF THREE               C
C                IDENTIFICATION FIELDS FOR THE FACTOR SCORES.                 C
C       KKF    - INTEGER VARIABLE CONTAINING THE SECOND OF THREE              C
C                IDENTIFICATION FIELDS FOR THE FACTOR SCORES.                 C
C       KKG    - INTEGER VARIABLE CONTAINING THE THIRD OF THREE               C
C                IDENTIFICATION FIELDS FOR THE FACTOR SCORES.                 C
C       KLOW   - INTEGER VARIABLE CONTAINING THE DATA VALUE WITH THE          C
C                LOWEST NUMERICAL VALUE OF THE ORDER ANALYSIS DATA.           C
C       KOUNT  - INTEGER ARRAY CONTAINING THE NUMBER OF OBSERVATIONS          C
C                FOR EACH DISTINCT DATA VALUE IN THE SUBROUTINES              C
C                (LEVEL AND SORT1).                                           C
C       KOUNT  - INTEGER ARRAY CONTAINING THE NUMBER OF OBSERVATIONS          C
C                IN EACH OF THE GROUPS IN THE SUBROUTINE (GROUP).             C
C       KOUNT  - INTEGER VARIABLE CONTAINING FLAG WITH PURPOSE OF             C
C                PLOTTING ONLY FOUR POINTS FOR THE PLOT OF                    C
C                EXTREME DATA VALUES IN THE SUBROUTINE (PLOT).                C
C       KREF   - INTEGER VARIABLE CONTAINING TEMPORARY STORAGE OF THE         C
C                VARIABLE (ICON) DURING FACTOR ANALYSIS.                      C
C       KURTOS - REAL VARIABLE CONTAINING THE STATISTICAL VALUE FOR           C
C                KURTOSIS.                                                    C
```

```
C         L     - INTEGER VARIABLE CONTAINING THE NUMBER OF PLOTTING          C
C                 SYMBOLS.                                                    C
C         LBL   - INTEGER VARIABLE CONTAINING PLOTTING CHARACTERS AND         C
C                 COMMAND WORDS FOR COMPARISON WITH INPUT COMMAND             C
C                 WORDS.                                                      C
C         LLA   - INTEGER VARIABLE CONTAINING THE DISK NUMBER THAT IS         C
C                 USED TO TRANSFER THE APPROPRIATE DATA VALUES IN THE         C
C                 ORDERING PROCESS.                                           C
C         LLB   - INTEGER VARIABLE CONTAINING THE DISK NUMBER THAT IS         C
C                 USED TO TRANSFER THE APPROPRIATE DATA VALUES IN THE         C
C                 ORDERING PROCESS.                                           C
C         LSAV  - INTEGER VARIABLE CONTAINING THE TEMPORARY STORAGE OF        C
C                 DISK NUMBERS USED FOR SWITCHING DISKS IN READING AND        C
C                 WRITING OF ORDER ANALYSIS DATA.                             C
C         LUA   - INTEGER VARIABLE CONTAINING THE DISK NUMBER                 C
C                 FOR WRITING PARTICULAR DATA FOR A CERTAIN ANALYSIS.         C
C         LUDATA - INTEGER VARIABLE CONTAINING A TAPE OR DISK NUMBER          C
C                 WITH ORIGINAL DATA FOR BUILDING MASTER DATA FILE (LU).      C
C         M     - INTEGER VARIABLE CONTAINING THE NUMBER OF VARIABLES         C
C                 FOR EACH ANALYSIS.                                          C
C         M     - INTEGER VARIABLE CONTAINING THE ORDER OF THE SQUARE         C
C                 MATRIX IN THE SUBROUTINE (MATINV).                          C
C         MAJ   - INTEGER VARIABLE CONTAINING THE DATA VALUE WITH THE         C
C                 MAJORITY USE WITHIN THE DATA VALUES OF ORDER ANALYSIS       C
C                 DATA.                                                       C
C         MAXKNT - INTEGER ARRAY CONTAINING THE NUMBER OF OBSERVATIONS        C
C                 WITH HIGHEST UNASSIGNED VALUES IN THE ORDER ANALYSIS        C
C                 DATA.                                                       C
C         MAXVAL - REAL VARIABLE CONTAINING THE MAXIMUM VALUE FOR THE         C
C                 DATA VALUES.                                                C
C         MDLEPT - INTEGER VARIABLE CONTAINING THE MIDPOINT OF THE            C
C                 NUMBER OF OBSERVATIONS.                                     C
C         MDLINE - INTEGER VARIABLE CONTAINING FLAG WITH THE PURPOSE OF       C
C                 PLOTTING MIDDLE BORDER AT DIFFERENT DIAMETERS.              C
C         MEAN  - REAL VARIABLE CONTAINING THE MEAN VALUE FOR THE DATA        C
C                 VALUES.                                                     C
C         MEDIAN - REAL VARIABLE CONTAINING THE MEDIAN VALUE FOR THE          C
C                 DATA VALUES.                                                C
C         MINKNT  INTEGER ARRAY CONTAINING THE NUMBER OF OBSERVATIONS         C
C                 WITH LOWEST UNASSIGNED VALUES IN THE ORDER ANALYSIS         C
C                 DATA.                                                       C
C         MINVAL - REAL VARIABLE CONTAINING THE MINIMUM VALUE FOR THE         C
C                 DATA VALUES.                                                C
C         MMQ   - INTEGER VARIABLE CONTAINING THE MAXIMUM NUMBER OF           C
C                 DIMENSIONS PLOTTED.                                         C
C         MODE  - REAL VARIABLE CONTAINING THE MODE VALUE FOR THE DATA        C
C                 VALUES.                                                     C
C         MQ    - INTEGER VARIABLE CONTAINING THE NUMBER OF FACTOR AXES       C
C                 PLOTTED IF NOT GREATER THAN FOUR.                           C
C         MREF  - INTEGER VARIABLE CONTAINING A TEMPORARY STORAGE FOR         C
C                 THE NUMBER OF VARIABLES DURING FACTOR ANALYSIS.             C
C         N     - INTEGER VARIABLE CONTAINING THE NUMBER OF FACTORS           C
C                 ROTATED IN THE SUBROUTINES (EXTRM AND FSCOR).               C
C         N     - INTEGER VARIABLE CONTAINING THE NUMBER OF                   C
C                 OBSERVATIONS FOR FACTOR ANALYSIS DATA IN THE                C
C                 SUBROUTINE (CORRE), OR FOR EACH GROUP IN THE                C
C                 SUBROUTINE (GROUP), OR FOR SORTING IN THE SUBROUTINE        C
C                 (SORT).                                                     C
C         N     - INTEGER VARIABLE CONTAINING THE NUMBER OF POINTS TO         C
C                 BE PLOTTED DURING THE CURRENT CALL TO THE SUBROUTINE        C
C                 (PLOT).                                                     C
C         N     - INTEGER VARIABLE CONTAINING THE NUMBER OF VARIABLES         C
C                 IN THE SUBROUTINE (EIGEN).                                  C
C         NCNT  - INTEGER VARIABLE CONTAINING A COUNTER FOR THE NUMBER        C
C                 OF OBSERVATIONS WITHIN EACH GROUP.                          C
C         ND    - INTEGER VARIABLE CONTAINING THE NUMBER OF ROTATED           C
```

```
C                FACTORS.                                               C
C       NDAT   - INTEGER VARIABLE CONTAINING THE TOTAL NUMBER OF        C
C                VARIABLES ON THE MASTER DATA FILE (LU).                C
C       ND21   - INTEGER VARIABLE CONTAINING THE TOTAL NUMBER OF        C
C                GROUPS WHICH EQUALS THE NUMBER OF ROTATED FACTORS      C
C                TIMES TWO PLUS ONE.                                    C
C       NF     - INTEGER VARIABLE CONTAINING A CERTAIN FACTOR NUMBER    C
C                DURING OUTPUT GENERATION WITHIN THE GROUPING OF        C
C                FACTOR SCORES.                                         C
C       NFLAG  - INTEGER VARIABLE CONTAINING A VALUE OF ZERO FOR ALL    C
C                ANALYSES OTHER THAN COMPARE ANALYSIS. IT IS FOR THE    C
C                PURPOSE OF CHECKING FOR A FACTOR ANALYSIS, ALWAYS TO   C
C                PRECEDE A COMPARE ANALYSIS.                            C
C       NID    - INTEGER VARIABLE CONTAINING THE NUMBER OF IDENTIFIER   C
C                FIELDS IN ORIGINAL DATA. THIS CANNOT BE GREATER THAN   C
C                3.                                                     C
C       NN     - INTEGER VARIABLE CONTAINING A VALUE OF ZERO IF         C
C                DOMINANT VECTOR IS POSITIVE OR A VALUE OF ONE IF THE   C
C                DOMINANT VECTOR IS NEGATIVE IN THE SUBROUTINE          C
C       NNN    - INTEGER VARIABLE CONTAINING A FLAG FOR DETERMINING     C
C                WHETHER FIRST TIME THROUGH THE GROUPING PROCESS OF     C
C                FACTOR AND COMPARE ANALYSES OR NOT.                    C
C       NNN    - INTEGER VARIABLE CONTAINING THE MAXIMUM NUMBER OF      C
C                POINTS PLOTTED DURING THE CURRENT CALL TO THE          C
C                SUBROUTINE (PLOT).                                     C
C       NOBS   - INTEGER VARIABLE CONTAINING THE NUMBER OF VALID        C
C                OBSERVATIONS FOR EACH ANALYSIS.                        C
C       NS     - INTEGER VARIABLE CONTAINING THE NUMBER OF              C
C                OBSERVATIONS USED IN CALCULATING FACTOR SCORES IN THE  C
C                SUBROUTINE (FSCOR), OR USED IN GROUPING OF FACTOR      C
C                SCORES IN THE SUBROUTINE (GRUPN), OR USED IN THE       C
C                ORDERING ANALYSIS OF SUBROUTINE (ORDER).               C
C       NSDZ   - INTEGER VARIABLE CONTAINING THE NUMBER OF              C
C                OBSERVATIONS WHOSE STANDARD DEVIATIONS ARE EQUAL TO    C
C                ZERO.                                                  C
C       NUMCAT - INTEGER VARIABLE CONTAINING THE NUMBER OF CATEGORIES   C
C                OR BARS IN THE HISTOGRAM.                              C
C       NUMDT  - INTEGER VARIABLE CONTAINING A COUNTER FOR THE NUMBER   C
C                OF OBSERVATIONS SO A LIMIT OF THE FIRST SIXTY          C
C                OBSERVATIONS WILL BE PRINTED IF THAT OPTION IS         C
C                INVOKED.                                               C
C       NUMOBS - INTEGER CONTAINING THE NUMBER OF OBSERVATIONS WITHIN   C
C                EACH GROUP FOR THE KENDAL AND ORDER ANALYSIS ON        C
C                GROUPED DATA.                                          C
C       NX     - INTEGER VARIABLE CONTAINING THE NUMBER OF              C
C                OBSERVATIONS TO BE READ FROM DISK AT VARIOUS STAGES    C
C                OF THE ORDERING PROCESS.                               C
C       NY     - INTEGER VARIABLE CONTAINING THE TOTAL NUMBER OF        C
C                OBSERVATIONS FOR A DATA SET.                           C
C       NZ     - INTEGER VARIABLE CONTAINING A COUNTER FOR THE NUMBER   C
C                OF OBJECTIONS TO CURRENT RANKINGS IN THE ORDERING      C
C       N1     - INTEGER VARIABLE CONTAINING THE FIRST VARIABLE FOR     C
C                A PARTICULAR ANALYSIS.                                 C
C       N2     - INTEGER VARIABLE CONTAINING THE LAST VARIABLE FOR      C
C                A PARTICULAR ANALYSIS.                                 C
C       N3     - INTEGER VARIABLE CONTAINING THE VARIABLE NUMBER FOR    C
C                OUTPUT PURPOSES.                                       C
C       PCT    - REAL VARIABLE CONTAINING THE WIDTH OF AN INDIVIDUAL    C
C                BAR IN THE HISTOGRAM BEFORE TRUNCATION.                C
C       PFLAG  - INTEGER VARIABLE CONTAINING A FLAG FOR READING DATA    C
C                FOR PLOTTING IN TWO DIFFERENT FORMATS.                 C
C       PR     - INTEGER ARRAY CONTAINING THE TITLE FOR EACH ANALYSES.  C
C       PRDAT  - INTEGER VARIABLE CONTAINING THE OPTION FOR PRINTING    C
C                THE FIRST SIXTY DATA VALUES.                           C
C       R      - REAL ARRAY CONTAINING CORRELATION COEFFICIENTS         C
C                AND SECONDLY, EIGENVALUES IN THE SUBROUTINE (FACTOR).  C
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```
C          R       - REAL ARRAY CONTAINING THE CORRELATION COEFFICIENTS           C
C                    FOR FACTOR ANALYSIS DATA IN THE SUBROUTINE (CORRE).          C
C          R       - REAL ARRAY CONTAINING THE EIGENVALUES IN THE DIAGONAL        C
C                    AND ARRANGED IN DESCENDING ORDER IN THE SUBROUTINE           C
C                    (LOAD).                                                      C
C          R       - REAL ARRAY CONTAINING THE EIGENVECTORS STORED                C
C                    COLUMNWISE IN THE SAME SEQUENCE AS EIGENVALUES IN            C
C                    THE SUBROUTINE (EIGEN).                                      C
C          RANGE   - REAL VARIABLE CONTAINING THE RANGE FOR THE DATA              C
C                    VALUES.                                                      C
C          RANVAL  - REAL ARRAY CONTAINING THE RANGE OF VALUES TO BE              C
C                    PLOTTED AS INDIVIDUAL BARS IN THE HISTOGRAM.                 C
C          REVERS  - REAL VARIABLE CONTAINING RANKINGS, REVERSED SO THAT          C
C                    HIGHEST PRIORITY ITEMS RECEIVE LARGEST SCORE.                C
C          RX      - REAL ARRAY CONTAINING THE SUM OF CROSS-PRODUCTS OF           C
C                    DEVIATIONS FROM MEANS FOR FACTOR ANALYSIS DATA.              C
C          S       - REAL ARRAY CONTAINING THE STANDARD DEVIATIONS AND            C
C                    SECONDLY, ROWS OF THE ROTATED FACTOR MATRIX FOR              C
C                    FACTOR ANALYSIS DATA.                                        C
C          SAVE    - REAL VARIABLE CONTAINING A TEMPORARY STORAGE OF A            C
C                    DATA ELEMENT BEING SORTED.                                   C
C          SD      - REAL ARRAY CONTAINING THE STANDARD DEVIATIONS.               C
C          SKEW    - REAL VARIABLE CONTAINING THE SKEWNESS VALUE FOR THE          C
C                    DATA VALUES.                                                 C
C          SQ      - REAL VARIABLE CONTAINING THE SQUARE ROOT FOR EACH OF         C
C                    THE EIGENVALUES.                                             C
C          STAR    - INTEGER VARIABLE CONTAINING THE ALPHANUMERIC SYMBOL          C
C                    USED TO CONSTRUCT THE BARS OF THE HISTOGRAM.                 C
C          STD     - REAL ARRAY CONTAINING THE STANDARD DEVIATIONS                C
C                    FOR FACTOR ANALYSIS DATA.                                    C
C          STDDEV  - REAL VARIABLE CONTAINING THE STANDARD DEVIATION              C
C                    VALUE FOR THE DATA VALUES.                                   C
C          STDERR  - REAL VARIABLE CONTAINING THE STANDARD ERROR VALUE FOR        C
C                    THE DATA VALUES.                                             C
C          SUM     - REAL VARIABLE CONTAINING THE SUM OF VARIABLES USED TO        C
C                    COMPARE WITH THE VALUE OF CORECT IN THE SUBROUTINE           C
C                    (DATCK), OR THE SUM OF FACTOR SCORES IN EACH GROUP IN        C
C                    THE SUBROUTINE (SORT).                                       C
C          SUMFSC  - REAL ARRAY CONTAINING A SUM VALUE OF FACTOR SCORES           C
C                    FOR EACH ROTATED FACTOR.                                     C
C          SUMMAT  - REAL ARRAY CONTAINING THE SUMMATION VALUES FOR EACH          C
C                    VARIABLE.                                                    C
C          SUMSQ   - REAL VARIABLE CONTAINING THE SUM OF SQUARES OF               C
C                    DEVIATION FOR DATA VALUES.                                   C
C          SUMXS   - REAL VARIABLE CONTAINING THE SUM VALUE FOR THE DATA          C
C                    VALUES.                                                      C
C          SUMXS2  - REAL VARIABLE CONTAINING THE SUM OF THE SQUARES VALUE        C
C                    FOR THE DATA VALUES.                                         C
C          SUMXS3  - REAL VARIABLE CONTAINING THE SUM OF THE CUBES VALUE          C
C                    FOR THE DATA VALUES.                                         C
C          SUMXS4  - REAL VARIABLE CONTAINING THE SUM OF THE DATA VALUES          C
C                    TO THE FOURTH POWER FOR THE DATA VALUES.                     C
C          T       - REAL ARRAY CONTAINING THE FINAL COMMUNALITIES.               C
C          THR     - REAL VARIABLE CONTAINING THE THRESHOLD.                      C
C          TOLR    - REAL VARIABLE CONTAINING THE TOLERANCE VALUE WITHIN          C
C                    WHICH TWO DATA VALUES ARE CONSIDERED EQUAL.                  C
C          TOTOBS  - REAL VARIABLE CONTAINING THE NUMBER OF OBSERVATIONS          C
C                    IN THE LEVEL ANALYSIS DATA.                                  C
C          UPLIM   - REAL VARIABLE CONTAINING THE CURRENT LOWER LIMIT FOR         C
C                    RANGE OF VALUES IN THE BARS OF THE HISTOGRAM.                C
C          V       - REAL ARRAY CONTAINING THE EIGENVECTORS COLUMNWISE            C
C                    UPON ENTERING THE SUBROUTINE (LOAD) BUT UPON RETURN          C
C                    THE ARRAY CONTAINS THE FACTOR MATRIX.                        C
C          V       - REAL ARRAY CONTAINING THE SUM OF CROSS-PRODUCTS OF           C
C                    DEVIATIONS FROM MEANS AND SECONDLY, THE FACTOR MATRIX        C
C                    IN THE SUBROUTINE (FACTOR).                                  C
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C        V        - REAL ARRAY CONTAINING THE FACTOR SCORES FOR EACH      C
C                   ROTATED FACTOR IN THE SUBROUTINES (EXTRM, FSCOR       C
C                   AND GRUPN).                                           C
C        VALUS    - REAL ARRAY CONTAINING EITHER DISTINCT DATA VALUES IN  C
C                   THE SUBROUTINES (LEVEL AND SORT1), OR DIVIDED TO      C
C                   CONTAIN ALL DATA VALUES AND IDENTIFICATION FIELDS     C
C                   FOR GROUPING IN FACTOR ANALYSIS.                      C
C        VAR      - REAL VARIABLE CONTAINING THE VARIANCE VALUE FOR THE   C
C                   DATA VALUES.                                          C
C        W        - REAL ARRAY CONTAINING THE MEANS FOR EACH VARIABLE OF  C
C                   THE FACTOR AND COMPARE ANALYSES DATA.                 C
C        X        - REAL ARRAY CONTAINING THE DATA VALUES USED TO         C
C                   CALCULATE FACTOR SCORES IN THE SUBROUTINE (FSCOR)# OR C
C                   DATA VALUES TO BE PLOTTED IN THE SUBROUTINE (PLOT)#   C
C                   OR DATA VALUES TO BE SORTED IN THE SUBROUTINE (SORT). C
C        X        - REAL ARRAY CONTAINING THE DISTANCE OF AN OBSERVATION  C
C                   FROM THE AVERAGE FOR THE CENTRAL CUBE VALUES OR       C
C                   OTHERWISE THE APPROPRIATE FACTOR SCORE FOR A CERTAIN  C
C                   FACTOR IN THE SUBROUTINE (GRUPN).                     C
C        X        - REAL ARRAY CONTAINING THE FACTOR SCORES FOR EACH      C
C                   FACTOR ROTATED IN THE SUBROUTINE (GROUP).             C
C        XBAR     - REAL ARRAY CONTAINING THE MEANS FOR FACTOR ANALYSIS   C
C                   DATA.                                                 C
C        XINCMT   - REAL VARIABLE CONTAINING THE SIZE OF THE RANGE OF     C
C                   DATA IN EACH CATEGORY AFTER THE NUMBER OF CATEGORIES  C
C                   IS REDUCED TO TEN.                                    C
C        XK       - REAL VARIABLE CONTAINING THE NUMBER OF OBSERVATIONS   C
C                   FOR EACH DISTINCT DATA VALUE.                         C
C        XMAX     - REAL VARIABLE CONTAINING THE MAXIMUM PERCENTAGE OF    C
C                   FREQUENCY FOR THE UNIQUE VALUES OCCURRING IN THE DATA C
C                   SET.                                                  C
C        XMEAN    - REAL VARIABLE CONTAINING THE MEAN VALUE USED TO       C
C                   CALCULATE THE KENDALLJS W COEFFICIENT OF CONCORDANCE. C
C        XNUM     - REAL ARRAY CONTAINING THE NUMERICAL VALUES FOR THE    C
C                   HORIZONTAL LEGEND OF THE X-AXIS.                      C
C        XTRM     - REAL ARRAY CONTAINING REVERSED VALUES OF EXTREME      C
C                   RANKINGS.                                             C
C        XX       - INTEGER MATRIX CONTAINING THE WHOLE PLOT INCLUDING    C
C                   LEGENDS, BORDERS, AND PLOTTED ITEMS IN THE SUBROUTINE C
C                   (PLOT).                                               C
C        XX       - INTEGER VARIABLE CONTAINING THE TEMPORARY STORAGE OF  C
C                   A DATA VALUE DURING SORTING IN THE SUBROUTINE (SORT). C
C        XXN      - INTEGER ARRAY CONTAINING THE NUMERICAL VALUES FOR THE C
C                   VERTICAL LEGEND OF THE Y-AXIS.                        C
C        Y        - REAL ARRAY CONTAINING THE STANDARD DEVIATIONS FOR     C
C                   FACTOR ANALYSIS DATA.                                 C
C        Z        - REAL ARRAY CONTAINING THE CORRECTIONS FOR THE FACTOR  C
C                   SCORES OF EACH ROTATED FACTOR IN THE SUBROUTINE       C
C                   (EXTRM AND FSCOR).                                    C
C        Z        - REAL VARIABLE CONTAINING THE CURRENT MAXIMUM VALUE    C
C                   FOR THE DOMINANT VECTOR IN THE SORTING PROCEDURE OF   C
C                   THE SUBROUTINE (GROUP).                               C
C        Z        - REAL VARIABLE CONTAINING THE VARIOUS POWERS OF THE    C
C                   DATA VALUES IN THE SUBROUTINE (LEVEL).                C
C                                                                         C
C                   ******************************************            C
C                                                                         C
C            PROGRAM FILES - TAPE1 REFERENCED BY THE VARIABLE (LU) IS     C
C        EQUIVALENCED TO A DISK THAT WILL STORE IN BINARY MODE THE        C
C        MASTER DATA FILE WITH ALL OBSERVATIONS AND THEIR IDENTIFIERS.    C
C        TAPE2 REFERENCED BY THE VARIABLE (LU2) IS EQUIVALENCED TO A      C
C        DISK THAT WILL STORE IN BINARY MODE THE DATA FILE WITH SPECIFIC  C
C        INPUT DATA FOR EACH ANALYSIS EXCEPT THE FACTOR AND COMPARE       C
C        ANALYSES.  TAPE3 REFERENCED BY THE VARIABLE (LU3) IS             C
C        EQUIVALENCED TO A DISK THAT WILL STORE IN BINARY MODE VARIOUS    C
C        OBSERVATIONS DURING DIFFERENT STAGES OF THE ORDER ANALYSIS.      C
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C         TAPE4 REFERENCED BY THE VARIABLE (LU4) IS EQUIVALENCED TO A         C
C         DISK THAT WILL STORE IN BINARY MODE THE DATA FILE FOR THE           C
C         SUBROUTINE (PLOT).  TAPE5 REFERENCED BY THE VARIABLE (LU5) IS       C
C         EQUIVALENCED TO THE INPUT FILE, IN THIS CASE THE CARD READER.       C
C         TAPE6 REFERENCED BY THE VARIABLE (LU6) IS EQUIVALENCED TO THE       C
C         OUTPUT FILE, IN THIS CASE THE LINE PRINTER.  TAPE7 REFERENCED       C
C         BY THE VARIABLE (LU7) IS EQUIVALENCED TO A DISK THAT WILL           C
C         STORE IN BINARY MODE THE VARIOUS OBSERVATIONS DURING DIFFERENT      C
C         STAGES OF THE ORDER ANALYSIS.  TAPE8 REFERENCED BY THE              C
C         VARIABLE (LU8) IS EQUIVALENCED TO A DISK THAT WILL STORE IN         C
C         BINARY MODE THE DATA FILE WITH INPUT DATA FOR FACTOR AND            C
C         COMPARE ANALYSES.  TAPE9 REFERENCED BY THE VARIABLE (LU9) IS        C
C         EQUIVALENCED TO A DISK THAT WILL STORE BINARY MODE THE RAW          C
C         FACTOR SCORE COEFFICIENTS AND CORRECTIONS FROM THE FACTOR           C
C         ANALYSIS FOR USE IN COMPARE ANALYSIS.  TAPE10 REFERENCED BY THE     C
C         VARIABLE (LU10) IS EQUIVALENCED TO THE HOLLERITH PUNCH FILE         C
C         THAT WILL PUNCH THE FACTOR SCORES CALCULATED BY THE FACTOR          C
C         ANALYSIS.  THESE VARIABLES ARE INITIALIZED AND EQUIVALENCED         C
C         IN THE BLOCK DATA SUBPROGRAM.                                       C
C                                                                             C
C                   ******************************************                C
C                                                                             C
C              FORMAT OF DATA ENTRIES ARE DESCRIBED IN ]PUBLIC -              C
C         A PROCEDURE FOR PUBLIC INVOLVEMENT].                                C
C                                                                             C
C                   ******************************************                C
C                                                                             C
C              REMARKS-   ALL CODING WITHIN THIS PROGRAM HAS BEEN             C
C         CONFORMED TO STANDARD ANSI FORTRAN EXCEPT THE PROGRAM               C
C         CARD WHICH IS PART OF CDC SCOPE 3.3 OPERATING SYSTEM.               C
C                                                                             C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C                                                                     PUBLC005
      INTEGER DATCNT,EXTOP,FMT(20),I,ICON,ID(3),IERR,IFAC             PUBLC006
      INTEGER IPRIN,IWIDE,IWORD,I1,J,KREF,LBL,LU,LUA,LUDATA,LU2,LU3,LU4 PUBLC007
      INTEGER LU5,LU6,LU7,LU8,LU9,LU10,M,MREF,NDAT,NFLAG,NID,NOBS,NUMDT PUBLC008
      INTEGER N1,N2,PR,PRDAT,VALUS                                    PUBLC009
      REAL CORECT,DATA(80)                                            PUBLC010
C                                                                     PUBLC011
      COMMON /ARRAY/ VALUS(5000)                                      PUBLC012
      COMMON /INPT/ NOBS,M,ICON,IPRIN,PR(18),N1,N2,DATCNT             PUBLC013
      COMMON /LABEL/ LBL(56)                                          PUBLC014
      COMMON /UNIT/ LU,LU2,LU3,LU4,LU5,LU6,LU7,LU8,LU9,LU10,IWIDE     PUBLC015
C                                                                     PUBLC016
      EQUIVALENCE (FMT(1),VALUS(1))                                   PUBLC017
C                                                                     PUBLC018
C . . . . . . ANALYSIS PERFORMED.                                     PUBLC019
C         1      DATA      = DATA INPUT                               PUBLC020
C         2      LEVEL     = MEAN,MEDIAN,MODE,KURTOSIS,ETC.           PUBLC021
C         3      KENDALL   = KENDALLS CONCORDANCE COEFFICIENT         PUBLC022
C         4      ORDER     = RANK ORDER OF PREFERENCES                PUBLC023
C         5      FACTOR    = PRINCIPAL COMPONENTS FACTOR ANALYSIS AND PUBLC024
C                            OPTIONAL RANKING FOR EXTREME POSITIONS ON PUBLC025
C                            EACH FACTOR.                             PUBLC026
C         6      COMPARE   = COMPARE A DATA SET TO ESTABLISHED FACTOR AXES PUBLC027
C         7      STOP      = END OF ANALYSIS                          PUBLC028
C         8      TITLE     = NEW TITLE ENTRY                          PUBLC029
C                                                                     PUBLC030
      DO 101 I=1,3                                                    PUBLC031
  101 ID(I)=LBL(8)                                                    PUBLC032
      IFAC=0                                                          PUBLC033
      MREF=0                                                          PUBLC034
      DATCNT=0                                                        PUBLC035
C                                                                     PUBLC036
C . . . . . . READ COMMAND WORDS AND PROBLEM NAME.                    PUBLC037
C                                                                     PUBLC038
```

```
  102 READ (LU5,128) IWORD
      DO 103 I=1,9
         IF (IWORD.EQ.LBL(I)) GO TO (105,110,110,110,110,110,127,103,104
     1   ), I
  103 CONTINUE
      WRITE (LU6,130) IWORD
      GO TO 127
  104 READ (LU5,128) (PR(I),I=1,18)
      GO TO 102
C
C . . . . . . TRANSFER DATA TO A MASS STORAGE DISK IN BINARY.
C
  105 DATCNT=DATCNT+1
      NUMDT=0
      READ (LU5,129) NID,NDAT,LUDATA,IWIDE,PRDAT
      READ (LU5,128) (FMT(I),I=1,20)
      IF (LUDATA.LE.0) LUDATA=LU5
      IF (LUDATA.NE.LU5) REWIND LUDATA
      REWIND LU
      IF (NID.LE.0) NID=3
      IF (NID.LE.3) GO TO 106
      WRITE (LU6,133)
      GO TO 127
  106 IF (NDAT.LE.0) NDAT=1
      IF (NDAT.LE.80) GO TO 107
      WRITE (LU6,137)
      GO TO 127
  107 IF (IWIDE.LE.0) IWIDE=0
      IF (PRDAT.LE.0) PRDAT=0
      IF (PRDAT.GT.0.AND.IWIDE.EQ.0) WRITE (LU6,134) DATCNT,(PR(I),I=1,1
     18)
      WRITE (LU) NID,NDAT
  108 READ (LUDATA,FMT) (ID(I),I=1,NID),(DATA(J),J=1,NDAT)
      NUMDT=NUMDT+1
      IF (PRDAT.LT.1.OR.IWIDE.GT.0) GO TO 109
      IF (ID(1).EQ.LBL(15)) GO TO 109
      IF (NUMDT.GT.60) GO TO 109
      WRITE (LU6,135) (ID(I),I=1,3),(DATA(J),J=1,NDAT)
  109 WRITE (LU) (ID(I),I=1,NID),(DATA(J),J=1,NDAT)
      IF (ID(1).EQ.LBL(15)) GO TO 102
      GO TO 108
C
C . . . . . . READ OTHER ANALYSIS COMMANDS EXCLUDING DATA AND TITLE.
C
  110 READ (LU5,129) N1,N2,ICON,IPRIN,EXTOP
      IF (N1.LT.1) N1=1
      IF (N2.LT.N1) N2=N1
      IF (N2.LE.NDAT) GO TO 111
      WRITE (LU6,136) IWORD,N2,NDAT
      GO TO 102
  111 IF (ICON.LE.2) ICON=2
      IF (ICON.GT.13) ICON=13
      IF (IPRIN.LE.0) IPRIN=0
      IF (EXTOP.LE.0) EXTOP=0
      LUA=LU2
      IF (IWORD.EQ.LBL(5).OR.IWORD.EQ.LBL(6)) LUA=LU8
      IF (IWORD.EQ.LBL(2)) GO TO 115
      REWIND LUA
      REWIND LU
      M=1+N2-N1
      CORECT=(M*(M+1))/2
      NOBS=0
C
C . . . . . . . CHECK OF DATA VALUES.
C
      READ (LU) NID,NDAT
```

```
  112 READ (LU) (ID(I),I=1,NID),(DATA(I),I=1,NDAT)
      IERR=0
      IF (ID(1).EQ.LBL(15)) GO TO 113
      CALL DATCK (IERR,CORECT,DATA,ID,N1,N2)
C
C . . . . . . TRANSFER OF GOOD DATA TO APPROPRIATE DISK FILE.
C
      IF (IERR.NE.0) GO TO 112
      NOBS=NOBS+1
      WRITE (LUA) (ID(I),I=1,3),(DATA(I),I=N1,N2)
      GO TO 112
  113 DO 114 I=1,7
        IF (IWORD.EQ.LBL(I)) GO TO (127,115,119,119,119,119,127), I
  114 CONTINUE
      WRITE (LU6,130) IWORD
      GO TO 127
C
C . . . . . . PROCESS LEVEL ANALYSIS.
C
  115 I1=N1
      DO 118 N1=I1,N2
        NOBS=0
        REWIND LUA
        REWIND LU
        READ (LU) NID,NDAT
  116   READ (LU) (ID(I),I=1,NID),(DATA(I),I=1,NDAT)
        IF (ID(1).EQ.LBL(15)) GO TO 117
        NOBS=NOBS+1
        WRITE (LUA) (ID(I),I=1,3),DATA(N1)
        GO TO 116
  117   CALL LEVEL
  118 CONTINUE
      GO TO 102
  119 IF (N2.GT.N1) GO TO 120
      WRITE (LU6,131) IWORD,N1,N2
      GO TO 102
  120 GO TO (127,127,121,122,123,125), I
C
C . . . . . . PROCESS KENDALL ANALYSIS.
C
  121 CALL KENDAL (1,0)
      GO TO 102
C
C . . . . . . PROCESS ORDER ANALYSIS.
C
  122 CALL ORDER (1,0)
      GO TO 102
C
C . . . . . . PROCESS FACTOR ANALYSIS.
C
  123 IFAC=1
      NFLAG=0
  124 CALL FACTOR (NFLAG,EXTOP)
      IF (NFLAG.EQ.99) IFAC=0
      MREF=M
      KREF=ICON
      GO TO 102
C
C . . . . . . PROCESS COMPARE ANALYSIS.
C
  125 IF (IFAC.NE.1.OR.M.NE.MREF.OR.ICON.NE.KREF) GO TO 126
      NFLAG=1
      GO TO 124
  126 WRITE (LU6,132)
      GO TO 102
C
```

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C . . . . . . PROCESS STOP.                                             PUBLC171
C                                                                       PUBLC172
  127 STOP                                                              PUBLC173
C                                                                       PUBLC174
C . . . . . . FORMATS USED IN THIS PROGRAM.                             PUBLC175
C                                                                       PUBLC176
  128 FORMAT (20A4)                                                     PUBLC177
  129 FORMAT (40I2)                                                     PUBLC178
  130 FORMAT (22H0 UNRECOGNIZED COMMAND,2X,A4)                          PUBLC179
  131 FORMAT (52H0MULTIVARIATE ANALYSIS REQUESTED FOR SINGLE VARIABLE/14PUBLC180
     1H CHECK COMMAND,2X,A4,2X,14HAND PARAMETERS,2X,2I6)                PUBLC181
  132 FORMAT (64H0COMPARATIVE FACTOR ANALYSIS NOT PRECEDED BY PRIMARY ANPUBLC182
     1ALYSIS OR/24H DIMENSIONED DIFFERENTLY)                            PUBLC183
  133 FORMAT (47H0 NUMBER OF IDENTIFICATION FIELDS EXCEEDS THREE)       PUBLC184
  134 FORMAT (////10H DATA SET ,I2,28H (FIRST 60 OBSERVATIONS) FOR/1H ,1PUBLC185
     18A4/)                                                             PUBLC186
  135 FORMAT (1H ,3A4,2X,35(F3.0)/1H ,41(F3.0))                         PUBLC187
  136 FORMAT (1H0,A4,36H ANALYSIS REQUESTED FOR DATA ELEMENT,I3,14H WHICPUBLC188
     1H EXCEEDS/38H TOTAL NUMBER OF DATA ELEMENTS INPUT (,I2,2H).)      PUBLC189
  137 FORMAT (1H0,41H TOTAL NUMBER OF DATA ELEMENTS EXCEEDS 80)         PUBLC190
C                                                                       PUBLC191
      END                                                               PUBLC192
      BLOCK DATA                                                        BLKDT001
C                                                                       BLKDT002
C . . . . . . THIS SUBPROGRAM (BLOCK DATA) ENTERS INITIAL VALUES INTO   BLKDT003
C       VARIABLES IN THE LABELED COMMON BLOCKS PRIOR TO PROGRAM         BLKDT004
C       EXECUTION.                                                      BLKDT005
C                                                                       BLKDT006
      INTEGER IWIDE,LBL,LU,LU2,LU3,LU4,LU5,LU6,LU7,LU8,LU9,LU10         BLKDT007
      REAL C                                                            BLKDT008
C                                                                       BLKDT009
      COMMON /LABEL/ LBL(56)                                            BLKDT010
      COMMON /QUAD/ C(9)                                                BLKDT011
      COMMON /UNIT/ LU,LU2,LU3,LU4,LU5,LU6,LU7,LU8,LU9,LU10,IWIDE       BLKDT012
C                                                                       BLKDT013
      DATA C(1)/.4306/,C(2)/.5936/,C(3)/.7108/,C(4)/.8017/,C(5)/.8761/  BLKDT014
      DATA C(6)/.9388/,C(7)/.9929/,C(8)/1.0404/,C(9)/1.0827/            BLKDT015
      DATA LBL(1)/4HDATA/,LBL(2)/4HLEVE/,LBL(3)/4HKEND/,LBL(4)/4HORDE/  BLKDT016
      DATA LBL(5)/4HFACT/,LBL(6)/4HCOMP/,LBL(7)/4HSTOP/,LBL(8)/4H    /  BLKDT017
      DATA LBL(9)/4HTITL/,LBL(10)/2HST/,LBL(11)/2HND/,LBL(12)/2HRD/     BLKDT018
      DATA LBL(13)/2HTH/,LBL(14)/1H\/,LBL(15)/4HEND /,LBL(16)/1H-/      BLKDT019
      DATA LBL(17)/1H./,LBL(18)/1H+/,LBL(19)/1H /,LBL(20)/1H1/          BLKDT020
      DATA LBL(21)/1H2/,LBL(22)/1H3/,LBL(23)/1H4/,LBL(24)/1H5/          BLKDT021
      DATA LBL(25)/1H6/,LBL(26)/1H7/,LBL(27)/1H8/,LBL(28)/1H9/          BLKDT022
      DATA LBL(29)/1H0/,LBL(30)/1H*/,LBL(31)/1HA/,LBL(32)/1HB/          BLKDT023
      DATA LBL(33)/1HC/,LBL(34)/1HD/,LBL(35)/1HE/,LBL(36)/1HF/          BLKDT024
      DATA LBL(37)/1HG/,LBL(38)/1HH/,LBL(39)/1HI/,LBL(40)/1HJ/          BLKDT025
      DATA LBL(41)/1HK/,LBL(42)/1HL/,LBL(43)/1HM/,LBL(44)/1HN/          BLKDT026
      DATA LBL(45)/1HO/,LBL(46)/1HP/,LBL(47)/1HQ/,LBL(48)/1HR/          BLKDT027
      DATA LBL(49)/1HS/,LBL(50)/1HT/,LBL(51)/1HU/,LBL(52)/1HV/          BLKDT028
      DATA LBL(53)/1HW/,LBL(54)/1HX/,LBL(55)/1HY/,LBL(56)/1HZ/          BLKDT029
      DATA LU/1/,LU2/2/,LU3/3/,LU4/4/,LU5/5/,LU6/6/,LU7/7/,LU8/8/,LU9/9/BLKDT030
      DATA LU10/10/                                                     BLKDT031
C                                                                       BLKDT032
      END                                                               BLKDT033
      SUBROUTINE CORRE (N,M,D,XBAR,STD,RX,R)                            CORRE001
C                                                                       CORRE002
C . . . . . . THIS SUBROUTINE (CORRE) IS CALLED BY THE SUBROUTINE       CORRE003
C       (FACTOR) TO COMPUTE MEANS, STANDARD DEVIATIONS, SUMS OF CROSS-  CORRE004
C       PRODUCTS OF DEVIATIONS, AND CORRELATION COEFFICIENTS.           CORRE005
C                                                                       CORRE006
      INTEGER I,ID(3),IWIDE,J,JK,K,L,LU,LU2,LU3,LU4,LU5,LU6,LU7,LU8     CORRE007
      INTEGER LU9,LU10,M,N                                              CORRE008
      REAL B(15),D(15),FN,R(120),RX(225),STD(15),XBAR(15)               CORRE009
C                                                                       CORRE010
      COMMON /UNIT/ LU,LU2,LU3,LU4,LU5,LU6,LU7,LU8,LU9,LU10,IWIDE       CORRE011
```

```
C                                                                  CORRE012
      DO 101 J=1,M                                                 CORRE013
  101 B(J)=0.0                                                     CORRE014
      K=(M*M+M)/2                                                  CORRE015
      DO 102 I=1,K                                                 CORRE016
  102 R(I)=0.0                                                     CORRE017
      FN=N                                                         CORRE018
C                                                                  CORRE019
C . . . . . . READ THE OBSERVATIONS ONE AT A TIME, SUM THE OBSERVATIONS,CORRE020
C        AND CALCULATE SUMS OF CROSS-PRODUCTS OF DEVIATIONS FROM MEANS. CORRE021
C                                                                  CORRE022
      DO 104 I=1,N                                                 CORRE023
         JK=0                                                      CORRE024
         READ (LU8) (ID(L),L=1,3),(D(L),L=1,M)                     CORRE025
         DO 103 J=1,M                                              CORRE026
  103    B(J)=B(J)+D(J)                                            CORRE027
      DO 104 J=1,M                                                 CORRE028
      DO 104 K=1,J                                                 CORRE029
         JK=JK+1                                                   CORRE030
  104 R(JK)=R(JK)+D(J)*D(K)                                        CORRE031
C                                                                  CORRE032
C . . . . . . . CALCULATE MEANS.                                   CORRE033
C                                                                  CORRE034
      JK=0                                                         CORRE035
      DO 105 J=1,M                                                 CORRE036
         XBAR(J)=B(J)/FN                                           CORRE037
C                                                                  CORRE038
C . . . . . . . ADJUST SUMS OF CROSS-PRODUCTS OF DEVIATIONS FROM MEANS. CORRE039
C                                                                  CORRE040
      DO 105 K=1,J                                                 CORRE041
         JK=JK+1                                                   CORRE042
  105 R(JK)=R(JK)-B(J)*B(K)/FN                                     CORRE043
C                                                                  CORRE044
C . . . . . . . CALCULATE CORRELATION COEFFICIENTS.                CORRE045
C                                                                  CORRE046
      JK=0                                                         CORRE047
      DO 106 J=1,M                                                 CORRE048
         JK=JK+J                                                   CORRE049
  106 STD(J)=SQRT(ABS(R(JK)))                                      CORRE050
      DO 109 J=1,M                                                 CORRE051
      DO 109 K=J,M                                                 CORRE052
         JK=J+(K*K-K)/2                                            CORRE053
         L=M*(J-1)+K                                               CORRE054
         RX(L)=R(JK)                                               CORRE055
         L=M*(K-1)+J                                               CORRE056
         RX(L)=R(JK)                                               CORRE057
         IF (STD(J)*STD(K)) 108,107,108                            CORRE058
  107    R(JK)=0.0                                                 CORRE059
         IF (J.EQ.K) R(JK)=1.0                                     CORRE060
         GO TO 109                                                 CORRE061
  108    R(JK)=R(JK)/(STD(J)*STD(K))                               CORRE062
  109 CONTINUE                                                     CORRE063
C                                                                  CORRE064
C . . . . . . . CALCULATE STANDARD DEVIATIONS.                     CORRE065
C                                                                  CORRE066
      FN=SQRT(FN-1.0)                                              CORRE067
      DO 110 J=1,M                                                 CORRE068
  110 STD(J)=STD(J)/FN                                             CORRE069
      RETURN                                                       CORRE070
C                                                                  CORRE071
      END                                                          CORRE072
      SUBROUTINE DATCK (IERR,CORECT,DATA,ID,N1,N2)                 DATCK001
C                                                                  DATCK002
C . . . . . . .THIS SUBROUTINE (DATCK) IS CALLED BY THE MAIN PROGRAM DATCK003
C        (PUBLIC) TO SET FLAG FOR BAD OBSERVATIONS WHICH WILL NOT BE DATCK004
C        USED FOR ANALYSIS AND REVERSES RANK DATA FOR THE PURPOSES OF DATCK005
C        FACTOR ANALYSIS.                                          DATCK006
C                                                                  DATCK007
```

```
      INTEGER I,ID(3),IERR,IWIDE,J,LU,LU2,LU3,LU4,LU5,LU6,LU7           DATCK008
      INTEGER LU8,LU9,LU10,N1,N2                                        DATCK009
      REAL CORECT,DATA(80),REVERS,SUM                                   DATCK010
C                                                                       DATCK011
      COMMON /UNIT/ LU,LU2,LU3,LU4,LU5,LU6,LU7,LU8,LU9,LU10,IWIDE       DATCK012
C                                                                       DATCK013
      SUM=0.0                                                           DATCK014
      REVERS=2*N2-N1                                                    DATCK015
      DO 101 I=N1,N2                                                    DATCK016
  101 SUM=SUM+DATA(I)                                                   DATCK017
      IF (ABS(SUM-CORECT).LT.1.0E-30) GO TO 102                         DATCK018
      IERR=1                                                            DATCK019
      WRITE (LU6,104) (ID(I),I=1,3),(DATA(J),J=N1,N2)                   DATCK020
      WRITE (LU6,105)                                                   DATCK021
      RETURN                                                            DATCK022
  102 DO 103 I=N1,N2                                                    DATCK023
  103 DATA(I)=REVERS-DATA(I)                                            DATCK024
      RETURN                                                            DATCK025
C                                                                       DATCK026
C . . . . . . FORMATS USED IN THIS SUBROUTINE.                          DATCK027
C                                                                       DATCK028
  104 FORMAT (////11H DATA ENTRY,2X,3A4/15H WITH VALUES OF,2X,15F3.0)   DATCK029
  105 FORMAT (35H IGNORED FOR THE FOLLOWING ANALYSIS)                   DATCK030
C                                                                       DATCK031
      END                                                               DATCK032
      SUBROUTINE EIGEN (N,R,A)                                          EIGEN001
C                                                                       EIGEN002
C . . . . . . THIS SUBROUTINE (EIGEN) IS CALLED BY THE SUBROUTINE       EIGEN003
C       (FACTOR) TO COMPUTE EIGENVALUES AND EIGENVECTORS.               EIGEN004
C                                                                       EIGEN005
      INTEGER I,IA,IJ,IL,ILQ,ILR,IM,IMQ,IMR,IND,IQ,J,JQ,K,L,LL,LM,LQ,M  EIGEN006
      INTEGER MM,MQ,N                                                   EIGEN007
      REAL A(120),ANORM,ANRMX,COSX,COSX2,R(225),SINCS,SINX,SINX2,THR,X  EIGEN008
      REAL Y                                                            EIGEN009
C                                                                       EIGEN010
C . . . . . . GENERATE IDENTITY MATRIX.                                 EIGEN011
C                                                                       EIGEN012
      IQ=-N                                                             EIGEN013
      DO 102 J=1,N                                                      EIGEN014
         IQ=IQ+N                                                        EIGEN015
      DO 102 I=1,N                                                      EIGEN016
         IJ=IQ+I                                                        EIGEN017
         R(IJ)=0.0                                                      EIGEN018
         IF (I-J) 102,101,102                                           EIGEN019
  101    R(IJ)=1.0                                                      EIGEN020
  102 CONTINUE                                                          EIGEN021
C                                                                       EIGEN022
C . . . . . . COMPUTE INITIAL AND FINAL NORMS (ANORM AND ANORMX).       EIGEN023
C                                                                       EIGEN024
      ANORM=0.0                                                         EIGEN025
      DO 104 I=1,N                                                      EIGEN026
      DO 104 J=I,N                                                      EIGEN027
         IF (I-J) 103,104,103                                           EIGEN028
  103    IA=I+(J*J-J)/2                                                 EIGEN029
         ANORM=ANORM+A(IA)*A(IA)                                        EIGEN030
  104 CONTINUE                                                          EIGEN031
      IF (ANORM) 129,129,105                                            EIGEN032
  105 ANORM=1.414*SQRT(ANORM)                                           EIGEN033
      ANRMX=ANORM*1.0E-6/FLOAT(N)                                       EIGEN034
C                                                                       EIGEN035
C . . . . . . INITIALIZE INDICATORS AND COMPUTE THRESHOLD.              EIGEN036
C                                                                       EIGEN037
      IND=0                                                             EIGEN038
      THR=ANORM                                                         EIGEN039
```

```
  106 THR=THR/FLOAT(N)                                                   EIGEN040
  107 L=1                                                                EIGEN041
  108 M=L+1                                                              EIGEN042
C                                                                        EIGEN043
C . . . . . . COMPUTE SIN AND COS.                                        EIGEN044
C                                                                        EIGEN045
  109 MQ=(M*M-M)/2                                                       EIGEN046
      LQ=(L*L-L)/2                                                       EIGEN047
      LM=L+MQ                                                            EIGEN048
      IF (ABS(A(LM))-THR) 122,110,110                                    EIGEN049
  110 IND=1                                                              EIGEN050
      LL=L+LQ                                                            EIGEN051
      MM=M+MQ                                                            EIGEN052
      X=0.5*(A(LL)-A(MM))                                                EIGEN053
      Y=-A(LM)/SQRT(A(LM)*A(LM)+X*X)                                     EIGEN054
      IF (X) 111,112,112                                                 EIGEN055
  111 Y=-Y                                                               EIGEN056
  112 SINX=Y/SQRT(2.0*(1.0+(SQRT(ABS(1.0-Y*Y)))))                        EIGEN057
      SINX2=SINX*SINX                                                    EIGEN058
      COSX=SQRT(1.0-SINX2)                                               EIGEN059
      COSX2=COSX*COSX                                                    EIGEN060
      SINCS=SINX*COSX                                                    EIGEN061
C                                                                        EIGEN062
C . . . . . . ROTATE L AND M COLUMNS.                                     EIGEN063
C                                                                        EIGEN064
      ILQ=N*(L-1)                                                        EIGEN065
      IMQ=N*(M-1)                                                        EIGEN066
      DO 121 I=1,N                                                       EIGEN067
        IQ=(I*I-I)/2                                                     EIGEN068
        IF (I-L) 113,120,113                                             EIGEN069
  113   IF (I-M) 114,120,115                                             EIGEN070
  114   IM=I+MQ                                                          EIGEN071
        GO TO 116                                                        EIGEN072
  115   IM=M+IQ                                                          EIGEN073
  116   IF (I-L) 117,118,118                                             EIGEN074
  117   IL=I+LQ                                                          EIGEN075
        GO TO 119                                                        EIGEN076
  118   IL=L+IQ                                                          EIGEN077
  119   X=A(IL)*COSX-A(IM)*SINX                                          EIGEN078
        A(IM)=A(IL)*SINX+A(IM)*COSX                                      EIGEN079
        A(IL)=X                                                          EIGEN080
  120   ILR=ILQ+I                                                        EIGEN081
        IMR=IMQ+I                                                        EIGEN082
        X=R(ILR)*COSX-R(IMR)*SINX                                        EIGEN083
        R(IMR)=R(ILR)*SINX+R(IMR)*COSX                                   EIGEN084
        R(ILR)=X                                                         EIGEN085
  121 CONTINUE                                                           EIGEN086
      X=2.0*A(LM)*SINCS                                                  EIGEN087
      Y=A(LL)*COSX2+A(MM)*SINX2-X                                        EIGEN088
      X=A(LL)*SINX2+A(MM)*COSX2+X                                        EIGEN089
      A(LM)=(A(LL)-A(MM))*SINCS+A(LM)*(COSX2-SINX2)                      EIGEN090
      A(LL)=Y                                                            EIGEN091
      A(MM)=X                                                            EIGEN092
C                                                                        EIGEN093
C . . . . . . TEST FOR M=LAST COLUMN.                                     EIGEN094
C                                                                        EIGEN095
  122 IF (M-N) 123,124,123                                               EIGEN096
  123 M=M+1                                                              EIGEN097
      GO TO 109                                                          EIGEN098
C                                                                        EIGEN099
C . . . . . . TEST FOR L=SECOND FROM LAST COLUMN.                         EIGEN100
C                                                                        EIGEN101
  124 IF (L-(N-1)) 125,126,125                                           EIGEN102
  125 L=L+1                                                              EIGEN103
      GO TO 108                                                          EIGEN104
  126 IF (IND-1) 128,127,128                                             EIGEN105
```

```
  127 IND=0
      GO TO 107
C
C . . . . . . COMPARE THRESHOLD WITH FINAL NORM.
C
  128 IF (THR-ANRMX) 129,129,106
C
C . . . . . . SORT EIGENVALUES AND EIGENVECTORS.
C
  129 IQ=-N
      DO 132 I=1,N
         IQ=IQ+N
         LL=I+(I*I-I)/2
         JQ=N*(I-2)
      DO 132 J=I,N
         JQ=JQ+N
         MM=J+(J*J-J)/2
         IF (A(LL)-A(MM)) 130,132,132
  130    X=A(LL)
         A(LL)=A(MM)
         A(MM)=X
         DO 131 K=1,N
            ILR=IQ+K
            IMR=JQ+K
            X=R(ILR)
            R(ILR)=R(IMR)
  131       R(IMR)=X
  132 CONTINUE
      RETURN
C
      END
      SUBROUTINE EXTRM (M,N)
C
C . . . . . . THIS SUBROUTINE (EXTRM) IS CALLED BY THE SUBROUTINE
C         (FACTOR) TO IDENTIFY THOSE HYPOTHETICAL RANKINGS WHICH GIVE
C         RISE TO THE MOST EXTREME (POSITIVE AND NEGATIVE) FACTOR SCORES
C         ON EACH FACTOR.
C
      INTEGER I,ID(3),IFIRST,II,IJ,IWIDE,IXTRM(15),J,K,L,LBL,LU,LU2,LU3
      INTEGER LU4,LU5,LU6,LU7,LU8,LU9,LU10,M,N
      REAL C,FC(15,15),FMAX,V(15),XTRM(15),Z(15)
C
      COMMON /LABEL/ LBL(5,6)
      COMMON /LOADNG/ C(15,15)
      COMMON /UNIT/ LU,LU2,LU3,LU4,LU5,LU6,LU7,LU8,LU9,LU10,IWIDE
C
      DO 101 I=1,3
  101 ID(I)=LBL(8)
      REWIND LU9
      REWIND LU4
      READ (LU9) (Z(J),J=1,N),((FC(I,J),I=1,N),J=1,M)
C
C . . . . . . SORT FACTOR LOADINGS ON EACH FACTOR FROM HIGHEST TO
C         LOWEST, AND ASSIGN RANKINGS TO EACH VARIABLE ACCORDING TO
C         THIS ORDER.
C
      IJ=30
      DO 113 II=1,N
         IJ=IJ+1
         DO 104 I=1,M
            FMAX=C(II,1)
            K=1
            DO 103 J=2,M
               IF (FMAX-C(II,J)) 102,103,103
  102          FMAX=C(II,J)
               K=J
```

```
  103       CONTINUE
            IXTRM(K)=I
            C(II,K)=-1.E30
  104    CONTINUE
C
C . . . . . . CALCULATE FACTOR SCORES FOR THIS RANKING.
C
         IFIRST=0
  105    DO 106 I=1,M
  106    XTRM(I)=FLOAT(M+1-IXTRM(I))
         DO 108 J=1,N
            V(J)=0.0
            DO 107 K=1,M
  107       V(J)=V(J)+FC(J,K)*XTRM(K)
  108    CONTINUE
         DO 109 J=1,N
  109    V(J)=V(J)-Z(J)
C
C . . . . . . CHECK WHETHER THIS IS FIRST OR SECOND TIME THROUGH FOR
C        THIS FACTOR.
C
         IF (IFIRST.GT.0) GO TO 110
C
C . . . . . . WRITE RANKINGS AND FACTOR SCORES.
C
         WRITE (LU6,114) LBL(IJ),II
         WRITE (LU6,115) (I,IXTRM(I),I=1,M)
         GO TO 111
  110    WRITE (LU6,116) LBL(IJ),II
         WRITE (LU6,115) (I,IXTRM(I),I=1,M)
  111    WRITE (LU6,117) (V(J),J=1,N)
         WRITE (LU4) (ID(I),I=1,3),(V(J),J=1,N)
         IF (IFIRST.GT.0) GO TO 113
         IFIRST=IFIRST+1
         IJ=IJ+1
C
C . . . . . .REVERSE PRIORITY RANKING TO FIND NEGATIVE EXTREMIST.
C
         DO 112 I=1,M
  112    IXTRM(I)=M+1-IXTRM(I)
         GO TO 105
  113 CONTINUE
      L=2*N
      CALL PLOT (L,N,3,0)
      RETURN
C
C . . . . . . FORMATS USED IN THIS SUBROUTINE.
C
  114 FORMAT (28HOPOSITIVE EXTREME POSITION (,A1,11H) ON FACTOR,I2/9HOVA
     1RIABLE,5X,4HRANK)
  115 FORMAT (1H ,I6,I10)
  116 FORMAT (28HONEGATIVE EXTREME POSITION (,A1,11H) ON FACTOR,I2/9HOVA
     1RIABLE,5X,4HRANK)
  117 FORMAT (31HOFACTOR SCORES FOR THIS RANKING/1HO,11F6.2/1H ,4F6.2)
C
      END
      SUBROUTINE FACTOR (NFLAG,EXTOP)
C
C . . . . . . THIS SUBROUTINE (FACTOR) IS CALLED BY THE MAIN PROGRAM
C        (PUBLIC) TO PERFORM FACTOR ANALYSIS DIRECTING SEVERAL
C        SUBROUTINES.
C
      INTEGER DATCNT,EXTOP,I,IALPHA(26),ICON,ID(3),IPRIN,IWIDE,J,L
      INTEGER LBL,LL,LU,LU2,LU3,LU4,LU5,LU6,LU7,LU8,LU9,LU10,M,NFLAG
      INTEGER NOBS,NSDZ,N1,N2,N3,PR
      REAL B(15),D(15),FL,R(120),S(15),SD(15),T(15),V(225),VALUS
      REAL XBAR(15)
C
```

```
      COMMON /ARRAY/ VALUS(5000)
      COMMON /INPT/ NOBS,M,ICON,IPRIN,PR(18),N1,N2,DATCNT
      COMMON /LABEL/ LBL(56)
      COMMON /LOADNG/ FL(15,15)
      COMMON /UNIT/ LU,LU2,LU3,LU4,LU5,LU6,LU7,LU8,LU9,LU10,IWIDE
C
      EQUIVALENCE (IALPHA(1),LBL(31))
C
      DO 101 I=1,3
  101 ID(I)=LBL(8)
      REWIND LU8
      IF (NFLAG.EQ.1) GO TO 102
      WRITE (LU6,126) (PR(I),I=1,18),N1,N2,DATCNT,NOBS,M
      GO TO 103
  102 WRITE (LU6,132) (PR(I),I=1,18),N1,N2,DATCNT,NOBS,M
  103 CALL CORRE (NOBS,M,B,XBAR,S,V,R)
C
C . . . . . . PRINT MEANS, STANDARD DEVIATIONS, AND CORRELATION
C        COEFFICIENTS.
C
      IF (M.GT.6.AND.IWIDE.GT.0) GO TO 108
      DO 104 J=1,M
  104 XBAR(J)=(FLOAT(M)+1.0)-XBAR(J)
      IF (M.LE.10) GO TO 105
      N3=N1+9
      WRITE (LU6,125) (I,I=N1,N3)
      GO TO 106
  105 WRITE (LU6,125) (I,I=N1,N2)
  106 WRITE (LU6,127) (XBAR(J),J=1,M)
      DO 107 J=1,M
  107 XBAR(J)=(FLOAT(M)+1.0)-XBAR(J)
      WRITE (LU6,128) (S(J),J=1,M)
      IF (NFLAG.EQ.1) GO TO 123
  108 DO 109 LL=1,M
          SD(LL)=S(LL)
  109 CONTINUE
      IF (M.LE.6.OR.IWIDE.LE.0) WRITE (LU6,129)
      DO 113 I=1,M
          DO 112 J=1,M
              IF (I-J) 110,111,111
  110         L=I+(J*J-J)/2
              GO TO 112
  111         L=J+(I*I-I)/2
  112     D(J)=R(L)
          IF (M.LE.6.OR.IWIDE.LE.0) WRITE (LU6,130) I,(D(J),J=1,M)
  113 CONTINUE
C
C . . . . . . COUNT THE NUMBER OF VARIABLES WITH ZERO STANDARD
C        DEVIATION.
C
      NSDZ=0
      DO 114 J=1,M
          IF (ABS(S(J)).GT.1.0E-30) GO TO 114
          NSDZ=NSDZ+1
  114 CONTINUE
C
C . . . . . . REDUCE ICON, IF NECESSARY, TO BE LESS THAN NUMBER OF
C        VARIABLES WITH NON-ZERO STANDARD DEVIATION.
C
      IF (ICON.LE.(M-NSDZ-1)) GO TO 116
      ICON=M-NSDZ-1
      IF (ICON.LT.2) GO TO 115
      IF (NSDZ.GT.0) WRITE (LU6,137) NSDZ
      IF (NSDZ.EQ.0) WRITE (LU6,140)
```

```
      WRITE (LU6,139) ICON,ICON                                          FACTR077
      GO TO 116                                                          FACTR078
  115 WRITE (LU6,137) NSDZ                                               FACTR079
      WRITE (LU6,138)                                                    FACTR080
      NFLAG=99                                                           FACTR081
      RETURN                                                             FACTR082
C                                                                        FACTR083
C . . . . . . CALCULATE AND PRINT PROPORTION OF CONTRIBUTION OF          FACTR084
C     EIGENVALUES.                                                       FACTR085
C                                                                        FACTR086
  116 CALL EIGEN (M,V,R)                                                 FACTR087
      L=0                                                                FACTR088
      DO 117 I=1,M                                                       FACTR089
         L=L+I                                                           FACTR090
         D(I)=R(L)/FLOAT(M)                                              FACTR091
  117 CONTINUE                                                           FACTR092
      IF (M.LE.6.OR.IWIDE.LE.0) WRITE (LU6,131) (D(J),J=1,M)             FACTR093
      CALL LOAD (M,ICON,V,R)                                             FACTR094
      CALL VARMX (M,ICON,V,B,D,T)                                        FACTR095
      REWIND LU4                                                         FACTR096
      IF (ICON.LE.6.OR.IWIDE.LE.0) WRITE (LU6,133) ICON                  FACTR097
      REWIND LU9                                                         FACTR098
      DO 119 I=1,M                                                       FACTR099
         DO 118 J=1,ICON                                                 FACTR100
            L=M*(J-1)+I                                                  FACTR101
            S(J)=V(L)                                                    FACTR102
  118    FL(J,I)=S(J)                                                    FACTR103
C                                                                        FACTR104
C . . . . . . STORE ROTATED FACTOR MATRIX ON DEVICES LU9 AND LU4. THEN   FACTR105
C     PRINT ON OUTPUT FILE.                                              FACTR106
C                                                                        FACTR107
         WRITE (LU9) (S(J),J=1,ICON)                                     FACTR108
         WRITE (LU4) (ID(J),J=1,3),(S(J),J=1,ICON)                       FACTR109
         N3=N1+I-1                                                       FACTR110
         IF (ICON.LE.6.OR.IWIDE.LE.0) WRITE (LU6,134) N3,IALPHA(I),(S(J)FACTR111
     1   ,J=1,ICON)                                                      FACTR112
  119 CONTINUE                                                           FACTR113
      CALL PLOT (M,ICON,1,0)                                             FACTR114
C                                                                        FACTR115
C . . . . . . PRINT COMMUNALITIES IF ANY DIFFERENCES ARE GREATER THAN    FACTR116
C     0.001.                                                             FACTR117
C                                                                        FACTR118
      DO 120 I=1,M                                                       FACTR119
      IF (D(I).GT.0.001) GO TO 121                                       FACTR120
  120 CONTINUE                                                           FACTR121
      GO TO 123                                                          FACTR122
  121 WRITE (LU6,135)                                                    FACTR123
      DO 122 I=1,M                                                       FACTR124
      N3=N1+I-1                                                          FACTR125
  122 WRITE (LU6,136) N3,B(I),T(I),D(I)                                  FACTR126
C                                                                        FACTR127
C . . . . . . CONTINUE FACTOR ANALYSIS WITH CALCULATION OF FACTOR        FACTR128
C     SCORES.                                                            FACTR129
C                                                                        FACTR130
  123 CALL FSCOR (M,ICON,XBAR,SD,V,NFLAG)                                FACTR131
      IF (NFLAG.EQ.99) RETURN                                            FACTR132
      REWIND LU8                                                         FACTR133
C                                                                        FACTR134
C . . . . . . PROCESS EXTREME ANALYSIS IF DESIRED.                       FACTR135
C                                                                        FACTR136
      IF (NFLAG.GT.0.OR.EXTOP.GT.0) GO TO 124                            FACTR137
      CALL EXTRM (M,ICON)                                                FACTR138
  124 RETURN                                                             FACTR139
C                                                                        FACTR140
C . . . . . . FORMATS USED IN THIS SUBROUTINE.                           FACTR141
C                                                                        FACTR142
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  125 FORMAT (17HOVARIABLE NUMBERS/1X,10(5X,I3,3X))                      FACTR143
  126 FORMAT (21H1FACTOR ANALYSIS...../1X,18A4/13H FOR VARIABLE,I3,17H TFACTR144
     1HROUGH VARIABLE,I3,12H OF DATA SET,I3//3X,12HNO. OF CASES,4X,I6/3XFACTR145
     2,16HNO. OF VARIABLES,I6/)                                           FACTR146
  127 FORMAT (6HOMEANS/1X,10F11.5/1X,5F11.5)                              FACTR147
  128 FORMAT (20HOSTANDARD DEVIATIONS/1X,10F11.5/1X,5F11.5)               FACTR148
  129 FORMAT (25HOCORRELATION COEFFICIENTS)                               FACTR149
  130 FORMAT (4HOROW,I3/1X,10F11.5/1X,5F11.5)                             FACTR150
  131 FORMAT (26HOPROPORTION OF EIGENVALUES/1X,10F11.5/1X,5F11.5)         FACTR151
  132 FORMAT (22H1COMPARE ANALYSIS...../1X,18A4/13H FOR VARIABLE,I3,17H FACTR152
     1THROUGH VARIABLE,I3,12H OF DATA SET,I3//3X,12HNO. OF CASES,4X,I6/3FACTR153
     2X,16HNO. OF VARIABLES,I6/)                                          FACTR154
  133 FORMAT (1HO/24H ROTATED FACTOR MATRIX (,I3,9H FACTORS))             FACTR155
  134 FORMAT (9HOVARIABLE,I3,1H=,A1/1X,10F11.5/1X,5F11.5)                 FACTR156
  135 FORMAT (1HO/23H CHECK ON COMMUNALITIES//9H VARIABLE,7X,8HORIGINAL,FACTR157
     112X,5HFINAL,10X,10HDIFFERENCE)                                      FACTR158
  136 FORMAT (1H ,I6,3(F11.5,1X))                                         FACTR159
  137 FORMAT (1HO,I2,44H VARIABLES HAVE STANDARD DEVIATIONS OF ZERO.)     FACTR160
  138 FORMAT (58H MEANINGFUL FACTOR ANALYSIS NOT POSSIBLE ON THIS DATA SFACTR161
     1ET.)                                                                FACTR162
  139 FORMAT (25H ROTATION OF A MAXIMUM OF,I3,17H FACTORS POSSIBLE/45H FFACTR163
     1ACTOR ANALYSIS CONTINUES WITH ICON RESET TO,I3)                     FACTR164
  140 FORMAT (1HO,63HNUMBER OF ROTATED FACTORS MUST BE LESS THAN NUMBER FACTR165
     1OF VARIABLES)                                                       FACTR166
C                                                                         FACTR167
      END                                                                 FACTR168
      SUBROUTINE FSCOR (M,N,W,Y,C,NFLAG)                                  FSCOR001
C                                                                         FSCOR002
C . . . . . . THIS SUBROUTINE (FSCOR) IS CALLED BY THE SUBROUTINE         FSCOR003
C          (FACTOR) TO COMPUTE FACTOR SCORES FOR NS SUBJECTS ON N FACTORS FSCOR004
C          FROM M TESTS.  THE CONCEPT WAS ADOPTED FROM A COOLEY-LOHNES     FSCOR005
C          PROGRAM.                                                       FSCOR006
C                                                                         FSCOR007
      INTEGER DATCNT,DUM,I,ICON,ID(3),II,IPRIN,ISTORE,IWIDE,J,K,LU,LU2    FSCOR008
      INTEGER LU3,LU4,LU5,LU6,LU7,LU8,LU9,LU10,M,N,ND21,NFLAG,NNN,NS      FSCOR009
      INTEGER N1,N2,PR                                                    FSCOR010
      REAL AVEFSC(15),C(15,15),D(15,15),SUMFSC(15),V(15),VALUS,W(15)      FSCOR011
      REAL X(15),Y(15),Z(15)                                              FSCOR012
C                                                                         FSCOR013
      COMMON /ARRAY/ VALUS(5000)                                          FSCOR014
      COMMON /INPT/ NS,DUM,ICON,IPRIN,PR(18),N1,N2,DATCNT                 FSCOR015
      COMMON /UNIT/ LU,LU2,LU3,LU4,LU5,LU6,LU7,LU8,LU9,LU10,IWIDE         FSCOR016
C                                                                         FSCOR017
      WRITE (LU6,115)                                                     FSCOR018
      IF (NFLAG.EQ.1) GO TO 107                                           FSCOR019
      REWIND LU9                                                          FSCOR020
C                                                                         FSCOR021
C . . . . . . READ FACTOR MATRIX AND MULTIPLY IT BY ITS TRANSPOSE.        FSCOR022
C                                                                         FSCOR023
      DO 101 J=1,M                                                        FSCOR024
          READ (LU9) (C(K,J),K=1,N)                                       FSCOR025
  101 CONTINUE                                                            FSCOR026
      DO 102 J=1,N                                                        FSCOR027
      DO 102 K=1,N                                                        FSCOR028
          D(J,K)=0.0                                                      FSCOR029
      DO 102 I=1,M                                                        FSCOR030
  102 D(J,K)=D(J,K)+C(J,I)*C(K,I)                                         FSCOR031
C                                                                         FSCOR032
C . . . . . . INVERT THE MATRIX (D).                                      FSCOR033
C                                                                         FSCOR034
      CALL MATINV (N,D)                                                   FSCOR035
      DO 104 K=1,M                                                        FSCOR036
          DO 103 J=1,N                                                    FSCOR037
              Z(J)=0.0                                                    FSCOR038
          DO 103 I=1,N                                                    FSCOR039
  103     Z(J)=Z(J)+C(I,K)*D(I,J)                                         FSCOR040
```

```
      DO 104 I=1,N
  104 C(I,K)=Z(I)
C
C . . . . . . THE MATRIX (C) NOW CONTAINS COEFFICIENTS COMPUTED AS
C        (A * ((A-PRIME * A) INVERSE)) TRANSPOSE.
C
      DO 105 J=1,N
      DO 105 K=1,M
         IF (ABS(Y(K)).LT.1.0E-30) Y(K)=1.0E30
  105 C(J,K)=C(J,K)/Y(K)
      DO 106 J=1,N
         Z(J)=0.0
      DO 106 K=1,M
  106 Z(J)=Z(J)+C(J,K)*W(K)
      REWIND LU9
      WRITE (LU9) (Z(J),J=1,N),((C(J,K),J=1,N),K=1,M)
C
C . . . . . . RAW SCORE WEIGHTS ARE NOW IN MATRIX (C), AND CORRECTIONS
C        ARE IN ARRAY (Z).
C
      GO TO 108
  107 REWIND LU9
      READ (LU9) (Z(J),J=1,N),((C(J,K),J=1,N),K=1,M)
  108 NNN=0
      REWIND LU8
      REWIND LU2
      REWIND LU4
      IF (N.LT.2) N=2
      ND21=N*2+1
C
C . . . . . . CALCULATE FACTOR SCORES AND AN AVERAGE FOR THE FACTOR
C        SCORES.
C
      DO 109 J=1,N
         SUMFSC(J)=0.0
         AVEFSC(J)=0.0
  109 CONTINUE
      DO 112 I=1,NS
         READ (LU8) (ID(J),J=1,3),(X(J),J=1,M)
         DO 110 J=1,N
            V(J)=0.0
         DO 110 K=1,M
  110    V(J)=V(J)+C(J,K)*X(K)
         DO 111 J=1,N
            V(J)=V(J)-Z(J)
  111    SUMFSC(J)=SUMFSC(J)+V(J)
         CALL GROUP (ID,NNN,V,N,ND21,ISTORE)
         IF (IPRIN.EQ.1.OR.IPRIN.EQ.3) WRITE (LU6,116) (ID(II),II=1,3),
     1   (V(J),J=1,N)
         IF (IPRIN.GE.2) WRITE (LU10,114) (ID(II),II=1,3),(V(J),J=1,N)
  112 WRITE (LU4) (ID(J),J=1,3),ISTORE,(V(J),J=1,N)
      DO 113 J=1,N
  113 AVEFSC(J)=SUMFSC(J)/FLOAT(NS)
      WRITE (LU6,117) (AVEFSC(J),J=1,N)
      REWIND LU4
      CALL GRUPN (NS,ND21,N)
      REWIND LU4
      CALL PLOT (NS,N,2,1)
      RETURN
C
C . . . . . . FORMATS USED IN THIS SUBROUTINE.
C
  114 FORMAT (3A4,13F5.2)
  115 FORMAT (1H0,6X,13HFACTOR SCORES/)
  116 FORMAT (6X,3A4,3X,8F6.2/(18X,5F6.2))
  117 FORMAT (1H0,9X,7HAVERAGE,4X,8F6.2/(18X,5F6.2))
```

```
C
      END
      SUBROUTINE GROUP (ID,N,X,ND,ND21,ISTORE)
C
C . . . . . . THIS SUBROUTINE (GROUP) IS CALLED BY THE SUBROUTINE
C        (FSCOR) TO SORT VARIABLES INTO SECTORS WHICH ARE EQUAL AREAS AT
C        EACH EXTREME AND A MIDDLE ZONE.
C
      INTEGER I,ID(3),ISTORE,IWIDE,J,K,KOUNT(27)
      INTEGER L,LU,LU2,LU3,LU4,LU5,LU6,LU7,LU8,LU9,LU10,N,ND,ND21,NN
      REAL C,CENT,EP,X(ND),Z
C
      COMMON /QUAD/ C(9)
      COMMON /UNIT/ LU,LU2,LU3,LU4,LU5,LU6,LU7,LU8,LU9,LU10,IWIDE
C
      ISTORE=0
C
C . . . . . . CHECK PARAMETERS AT FIRST ENTRY.
C
      IF (N.NE.0) GO TO 102
      DO 101 L=1,ND21
         KOUNT(L)=0
  101 CONTINUE
C
C . . . . . . VALUES OF CENT DETERMINES MIDDLE ZONE.
C
  102 IF (ND.LE.9) CENT=C(ND)
      EP=1.0/FLOAT(ND)
      EP=FLOAT(ND21)**EP
      IF (ND.GT.9) CENT=4.4/(2.0*EP)-0.5
      DO 103 K=1,ND
         IF (ABS(X(K)).GT.CENT) GO TO 104
  103 CONTINUE
      I=1
      GO TO 107
C
C . . . . . . CHECK FOR DOMINANT VECTOR.
C
  104 Z=0.0
      DO 105 L=1,ND
         IF ((ABS(X(L))).LT.Z) GO TO 105
         Z=ABS(X(L))
         K=L
  105 CONTINUE
      NN=0
      IF (X(K).GT.0.0) GO TO 106
      NN=1
  106 I=K*2+NN
  107 KOUNT(I)=KOUNT(I)+1
      N=KOUNT(I)
      IF (N.GT.1250) WRITE (LU6,108) (ID(J),J=1,3),X(K)
      IF (N.LE.1250) ISTORE=I
      RETURN
C
C . . . . . . FORMAT USED IN THIS SUBROUTINE.
C
  108 FORMAT (18H OVERFLOW OF CLASS,1X,16HWITH OBSERVATION,1X,3A4,2X,6HV
     1ALUE=,F12.4)
C
      END
      SUBROUTINE GRUPN (NY,ND21,ND)
C
C . . . . . . THIS SUBROUTINE (GRUPN) IS CALLED BY THE SUBROUTINE
C        (FSCOR) TO EXTRACT DATA FROM DATA TAPE ACCORDING TO GROUP
C        ASSIGNMENT AND PERFORM SORT, KENDAL AND ORDER ANALYSIS ON EACH
C        GROUP.
```

```
C
      INTEGER DATCNT,I,ICON,ID(3),IDD(3),IGZ,IPRIN,ISORT,ISTORE,IWIDE
      INTEGER J,JGRP,K,KD,LBL,LU,LU2,LU3,LU4,LU5,LU6,LU7,LU8,LU9,LU10,M
      INTEGER NCNT,ND,ND2,ND21,NF,NOBS,NS,NUMOBS,NY,N1,N2,PR
      REAL AVG,DATA(15),SUMSQ,V(15),X
C
      COMMON /ARRAY/ X(1250),KD(3,1250)
      COMMON /INPT/ NUMOBS,M,ICON,IPRIN,PR(18),N1,N2,DATCNT
      COMMON /LABEL/ LBL(56)
      COMMON /UNIT/ LU,LU2,LU3,LU4,LU5,LU6,LU7,LU8,LU9,LU10,IWIDE
C
      NS=NY
      WRITE (LU6,111)
      DO 108 ND2=1,ND21
         NOBS=0
         NCNT=0
         REWIND LU2
         REWIND LU4
         REWIND LU8
         IGZ=ND2/2
         DO 104 I=1,NS
            READ (LU8) (IDD(J),J=1,3),(DATA(J),J=1,M)
            READ (LU4) (ID(J),J=1,3),ISTORE,(V(J),J=1,ND)
            IF (ISTORE.NE.ND2) GO TO 104
            NOBS=NOBS+1
C
C . . . . . . WRITE DATA VALUES ONTO INPUT DISK FOR KENDALL AND ORDER
C        ANALYSIS OF GROUPS.
C
            WRITE (LU2) (IDD(J),J=1,3),(DATA(J),J=1,M)
            IF (ID(3).EQ.0.OR.ID(3).EQ.LBL(8)) GO TO 104
            NCNT=NCNT+1
            IF (ND2.NE.1) GO TO 102
            SUMSQ=0.0
            DO 101 J=1,ND
  101       SUMSQ=SUMSQ+V(J)*V(J)
            X(NCNT)=SQRT(SUMSQ)
            GO TO 103
  102       X(NCNT)=V(IGZ)
  103       KD(1,NCNT)=ID(1)
            KD(2,NCNT)=ID(2)
            KD(3,NCNT)=ID(3)
  104    CONTINUE
         ISORT=1
         IGZ=IGZ*2
         IF (IGZ.EQ.ND2) ISORT=0
         IF (NCNT.GE.2) CALL SORT (NCNT,ISORT,AVG)
         IF (ND2.EQ.1) WRITE (LU6,113)
         IF (ND2.GT.1) JGRP=ND2-1
         WRITE (LU6,109)
         IF (ND2.EQ.1) GO TO 105
         NF=IGZ/2
         IF (ISORT.EQ.0) WRITE (LU6,114) JGRP,NF
         IF (ISORT.EQ.1) WRITE (LU6,115) JGRP,NF
  105    IF (NCNT.EQ.0) GO TO 107
         DO 106 I=1,NCNT
            WRITE (LU6,112) (KD(K,I),K=1,3),X(I)
  106    CONTINUE
         IF (NCNT.GE.2) WRITE (LU6,110) AVG
  107    NUMOBS=NOBS
         IF (NOBS.LT.2) GO TO 108
         IF (ND2.EQ.1) JGRP=0
         CALL KENDAL (0,JGRP)
         CALL ORDER (0,JGRP)
  108 CONTINUE
      REWIND LU2
      NUMOBS=NS
      RETURN
C
```

```
C . . . . . . FORMATS USED IN THIS SUBROUTINE.
C
  109 FORMAT (//)
  110 FORMAT (/10X,10HAVERAGE = ,F13.3/)
  111 FORMAT (45H1 IDENTIFICATION OF INDIVIDUALS WITHIN GROUPS)
  112 FORMAT (1H ,8X,3A4,F12.3)
  113 FORMAT (31H0INDIVIDUALS CLOSEST TO AVERAGE)
  114 FORMAT (6H0GROUP,2X,I2,20H--POSITIVE ON FACTOR,I2)
  115 FORMAT (6H0GROUP,2X,I2,20H--NEGATIVE ON FACTOR,I2)
C
      END
      SUBROUTINE HIST (NUMCAT,CATEGS,RANVAL,XMAX,IFLAG)
C
C . . . . . . THIS SUBROUTINE (HIST) IS CALLED BY THE SUBROUTINE
C        (LEVEL) TO PLOT A HISTOGRAM OF OCCURENCES OF A UNIQUE NUMBER
C        OF VALUES AND PLOT THEM IN TERMS OF A PERCENTAGE OF THE TOTAL
C        NUMBER OF OBSERVATIONS FOR THIS PARTICULAR VARIABLE.
C
      INTEGER I,IFLAG,IWIDE,J,K,LBL,LU,LU2,LU3,LU4,LU5,LU6,LU7,LU8,LU9
      INTEGER LU10,NUMCAT,STAR
      REAL CATEGS(13),PCT,RANVAL(13),XMAX
C
      COMMON /LABEL/ LBL(56)
      COMMON /UNIT/ LU,LU2,LU3,LU4,LU5,LU6,LU7,LU8,LU9,LU10,IWIDE
C
      WRITE (LU6,102)
      STAR=LBL(14)
      DO 101 I=1,NUMCAT
         WRITE (LU6,103) CATEGS(I)
         PCT=(CATEGS(I)/XMAX)*60.0
         K=IFIX(PCT)
         IF (K.GT.64) K=64
         WRITE (LU6,104) RANVAL(I),(STAR,J=1,K)
  101 CONTINUE
      IF (IFLAG.EQ.1) WRITE (LU6,105)
      RETURN
C
C . . . . . . FORMATS USED IN THIS SUBROUTINE.
C
  102 FORMAT (1H0/1H0,51H(PERCENTAGES REPRESENTED ABOVE THE INDIVIDUAL B
     1ARS)//)
  103 FORMAT (7X,1HI,F6.1)
  104 FORMAT (1X,F6.2,1HI,80A1/7X,1HI)
  105 FORMAT (1H0,4H****,68HTHE VALUES PRINTED REPRESENT THE LOWER LIMIT
     1 OF A RANGE OF VALUES IE/1H0,5X,66HTHE RANGE FOR THE FIRST CATEGOR
     2Y IS---MAXVAL TO VALUE PRINTED ETC.)
C
      END
      SUBROUTINE KENDAL (CCNTRL,JGRP)
C
C . . . . . . THIS SUBROUTINE (KENDAL) IS CALLED BY THE MAIN PROGRAM
C        (PUBLIC) AND BY THE SUBROUTINE (GRUPN) TO COMPUTE KENDALLS
C        CONCORDANCE COEFFICIENT.
C
      INTEGER CCNTRL,DATCNT,I,ICON,ID(3),IDF,IPRIN,IWIDE,J,JGRP,K,LU,LU2
      INTEGER LU3,LU4,LU5,LU6,LU7,LU8,LU9,LU10,M,NOBS,N1,N2,PR
      REAL CHISQ,DATA(15),KENCC,SUMMAT(15),SUMSQ,XMEAN
C
      COMMON /INPT/ NOBS,M,ICON,IPRIN,PR(18),N1,N2,DATCNT
      COMMON /UNIT/ LU,LU2,LU3,LU4,LU5,LU6,LU7,LU8,LU9,LU10,IWIDE
C
      IF (CCNTRL.EQ.1) GO TO 101
      WRITE (LU6,108)
```

```
      IF (JGRP.GT.0) GO TO 100                                          KENDL016
      WRITE (LU6,114) (PR(I),I=1,18),N1,N2,DATCNT                       KENDL017
      GO TO 102                                                         KENDL018
  100 WRITE (LU6,113) JGRP,(PR(I),I=1,18),N1,N2,DATCNT                  KENDL019
      GO TO 102                                                         KENDL020
  101 WRITE (LU6,109)                                                   KENDL021
      WRITE (LU6,110) (PR(I),I=1,18),N1,N2,DATCNT                       KENDL022
C                                                                       KENDL023
C . . . . . . . CALCULATE SUM OF OBSERVATIONS FOR EACH VARIABLE.        KENDL024
C                                                                       KENDL025
  102 DO 103 I=1,M                                                      KENDL026
        SUMMAT(I)=0.0                                                   KENDL027
  103 CONTINUE                                                          KENDL028
      REWIND LU2                                                        KENDL029
      DO 105 I=1,NOBS                                                   KENDL030
        READ (LU2) (ID(K),K=1,3),(DATA(K),K=1,M)                        KENDL031
        DO 104 J=1,M                                                    KENDL032
          SUMMAT(J)=SUMMAT(J)+DATA(J)                                   KENDL033
  104   CONTINUE                                                        KENDL034
  105 CONTINUE                                                          KENDL035
C                                                                       KENDL036
C . . . . . . . CALCULATE SUM OF SQUARES, AND KENDALLJS CONCORDANCE     KENDL037
C       COEFFICIENT.                                                    KENDL038
C                                                                       KENDL039
      XMEAN=FLOAT(NOBS*(M+1))/2.0                                       KENDL040
      SUMSQ=0.0                                                         KENDL041
      DO 106 I=1,M                                                      KENDL042
        SUMSQ=SUMSQ+(SUMMAT(I)-XMEAN)*(SUMMAT(I)-XMEAN)                 KENDL043
  106 CONTINUE                                                          KENDL044
      KENCC=12.0*SUMSQ/FLOAT(NOBS*NOBS*(M*M*M-M))                       KENDL045
C                                                                       KENDL046
C . . . . . . . PRINT NUMBER OF OBSERVATIONS, NUMBER OF VARIABLES,      KENDL047
C       AND KENDALLJS CONCORDANCE COEFFICIENT.                          KENDL048
C                                                                       KENDL049
      WRITE (LU6,111) NOBS,M,KENCC                                      KENDL050
C                                                                       KENDL051
C . . . . . . . CALCULATE AND PRINT THE CHI SQUARE AND DEGREES OF       KENDL052
C       FREEDOM IF THE NUMBER OF VARIABLES IS GREATER THAN SEVEN.       KENDL053
C                                                                       KENDL054
      IF (M.LE.7) GO TO 107                                             KENDL055
      CHISQ=FLOAT(M*(NOBS-1))*KENCC                                     KENDL056
      IDF=M-1                                                           KENDL057
      WRITE (LU6,112) CHISQ,IDF                                         KENDL058
  107 REWIND LU2                                                        KENDL059
      RETURN                                                            KENDL060
C                                                                       KENDL061
C . . . . . . . FORMATS USED IN THIS SUBROUTINE.                        KENDL062
C                                                                       KENDL063
  108 FORMAT (1H0)                                                      KENDL064
  109 FORMAT (1H1)                                                      KENDL065
  110 FORMAT (36H KENDALL CONCORDANCE COEFFICIENT FOR/1H ,18A4/13H FOR VKENDL066
     1ARIABLE,I3,17H THROUGH VARIABLE,I3,12H OF DATA SET,I3)            KENDL067
  111 FORMAT (23H0NUMBER OF OBSERVATIONS,6X,I4/20H0NUMBER OF VARIABLES,9KENDL068
     1X,I4/21H0KENDALL COEFFICIENT=,4X,F8.3)                            KENDL069
  112 FORMAT (12H0CHI SQUARE=,F12.3,2X,3HFOR,I4,19H DEGREES OF FREEDOM) KENDL070
  113 FORMAT (42H KENDALL CONCORDANCE COEFFICIENT FOR GROUP,I4,3H OF/1H KENDL071
     1,18A4/13H FOR VARIABLE,I3,17H THROUGH VARIABLE,I3,12H OF DATA SET,KENDL072
     2I3)                                                               KENDL073
  114 FORMAT (57H KENDALL CONCORDANCE COEFFICIENT FOR THE AVERAGE GROUP KENDL074
     1OF/1H ,18A4/13H FOR VARIABLE,I3,17H THROUGH VARIABLE,I3,12H OF DATKENDL075
     2A SET,I3)                                                         KENDL076
C                                                                       KENDL077
      END                                                               KENDL078
      SUBROUTINE LEVEL                                                  LEVEL001
```

```
C
C. . . . . . THIS SUBROUTINE (LEVEL) IS CALLED BY THE MAIN PROGRAM
C     (PUBLIC) TO COMPUTE VARIOUS STATISTICS UPON SOME
C     OBSERVATIONS CONCERNING A PARTICULAR VARIABLE WITHIN THE
C     PRESENT DATA SET.
C
      INTEGER DATCNT,I,ICON,ID(3),IFLAG,INUM(4),IN1,IPRIN,ISMKNT,ITOP
      INTEGER IWIDE,J,K,KOUNT,LBL,LU,LU2,LU3,LU4,LU5,LU6,LU7,LU8,LU9
      INTEGER LU10,M,MDLEPT,NOBS,NUMCAT,N1,N2,PR
      REAL CATEGS(13),DATA,KURTOS,MAXVAL,MEAN,MEDIAN,MINVAL,MODE,RANGE
      REAL RANVAL(13),SKEW,STDDEV,STDERR,SUMXS,SUMXS2,SUMXS3
      REAL SUMXS4,TOLR,TOTOBS,UPLIM,VALUS,VAR,XINCMT,XK,XMAX,Z
C
      COMMON /ARRAY/ KOUNT(2500),VALUS(2500)
      COMMON /INPT/ NOBS,M,ICON,IPRIN,PR(18),N1,N2,DATCNT
      COMMON /LABEL/ LBL(56)
      COMMON /UNIT/ LU,LU2,LU3,LU4,LU5,LU6,LU7,LU8,LU9,LU10,IWIDE
C
      EQUIVALENCE (INUM(1),LBL(10))
C
      IN1=N1
      IF (IN1.GT.4) IN1=4
      WRITE (LU6,120) (PR(I),I=1,18),N1,INUM(IN1),DATCNT
      REWIND LU2
C
C . . . . . . CALCULATIONS OF VARIOUS STATISTICS IF NUMBER OF
C     OBSERVATIONS IS ONE.
C
      IF (NOBS.GT.1) GO TO 101
      READ (LU2) (ID(J),J=1,3),DATA
      MEDIAN=DATA
      MAXVAL=DATA
      MINVAL=DATA
      RANGE=0.0
      MEAN=DATA
      VAR=0.0
      STDDEV=0.0
      STDERR=0.0
      KURTOS=0.0
      SKEW=0.0
      MODE=DATA
      WRITE (LU6,122)
      GO TO 112
  101 TOLR=.001
  102 DO 103 I=1,2500
  103 KOUNT(I)=1
C
C . . . . . . COUNT THE NUMBER OF TIMES EACH DISTINCT VALUE OCCURS.
C
      REWIND LU2
      READ (LU2) (ID(I),I=1,3),DATA
      K=1
      VALUS(1)=DATA
      DO 105 I=2,NOBS
         READ (LU2) (ID(J),J=1,3),DATA
         DO 104 J=1,K
            IF (ABS(DATA-VALUS(J)).GT.TOLR) GO TO 104
            KOUNT(J)=KOUNT(J)+1
            GO TO 105
  104    CONTINUE
         K=K+1
         IF (K.GT.2500) GO TO 106
         VALUS(K)=DATA
  105 CONTINUE
      GO TO 107
  106 TOLR=TOLR*10.0
      GO TO 102
C
```

```
C . . . . . . SORT DISTINCT VALUES FROM LOW TO HIGH.
C
  107 CALL SORT1 (K)
C
C . . . . . . CALCULATE THE MEDIAN, RANGE, MAXIMUM AND MINIMUM VALUE
C       OF THE OBSERVATIONS.
C
      MAXVAL=VALUS(K)
      MINVAL=VALUS(1)
      RANGE=MAXVAL-MINVAL
      MDLEPT=NOBS/2+1
      ISMKNT=0
      DO 108 I=1,K
         ISMKNT=ISMKNT+KOUNT(I)
         IF (ISMKNT.GE.MDLEPT) GO TO 109
  108 CONTINUE
  109 MEDIAN=VALUS(I)
C
C . . . . . . CALCULATE THE MEAN, VARIANCE, STANDARD DEVIATION AND
C        STANDARD ERROR OF THE OBSERVATIONS, ALONG WITH THE SUM OF
C        OBSERVATIONS, SUM OF OBSERVATIONS SQUARED, SUM OF
C        OBSERVATIONS CUBED, AND SUM OF OBSERVATIONS TO THE FOURTH.
C
      SUMXS=0.0
      SUMXS2=0.0
      SUMXS3=0.0
      SUMXS4=0.0
      DO 110 I=1,K
         Z=VALUS(I)
         XK=FLOAT(KOUNT(I))
         SUMXS=SUMXS+Z*XK
         Z=Z*Z
         SUMXS2=SUMXS2+Z*XK
         SUMXS3=SUMXS3+Z*VALUS(I)*XK
         Z=Z*Z
         SUMXS4=SUMXS4+Z*XK
  110 CONTINUE
      MEAN=SUMXS/FLOAT(NOBS)
      TOTOBS=FLOAT(NOBS)
      VAR=(SUMXS2-((SUMXS*SUMXS)/TOTOBS))/(TOTOBS-1.0)
      STDDEV=SQRT(VAR)
      STDERR=STDDEV/SQRT(TOTOBS)
C
C . . . . . . COMPUTE KURTOSIS, SKEWNESS, AND MODE OF THE OBSERVATIONS.
C
      KURTOS=(SUMXS4-(4.0*MEAN*SUMXS3)+(6.0*SUMXS2*MEAN*MEAN)-(4.0*TOTOB
     1S*MEAN**4)+MEAN**4)/(STDDEV**4*TOTOBS)-3.0
      SKEW=(SUMXS3-3.0*TOTOBS*MEAN**3+3.0*MEAN*SUMXS2-MEAN**3)/(TOTOBS*S
     1TDDEV**3)
C
C . . . . . . FIND THE VALUE OCCURRING THE MOST TIMES.
C
      I=1
      ITOP=KOUNT(1)
      DO 111 J=2,K
         IF (ITOP.GT.KOUNT(J)) GO TO 111
         ITOP=KOUNT(J)
         I=J
  111 CONTINUE
      MODE=VALUS(I)
C
C . . . . . . OUTPUT STATISTICS ABOUT VARIABLE BEING PROCESSED.
C
  112 WRITE (LU6,121) MEAN,VAR,STDDEV,STDERR,SKEW,KURTOS,MODE,MEDIAN,RAN
     1GE,MINVAL,MAXVAL
      IF (NOBS.LE.1) RETURN
```

```
C
C . . . . . . COMPUTE THE PERCENTAGE THAT EACH UNIQUE VALUE OCCURS IN
C      THE TOTAL NUMBER OF OBSERVATIONS BY DETERMINING THE NUMBER
C      OF DISTINCT VALUES OCCURRING AND IF GREATER THAN 13 DIVIDE THE
C      RANGE INTO 13 AREAS.
C
      NUMCAT=K
      XMAX=0.0
      IFLAG=0
      DO 113 I=1,13
         CATEGS(I)=0.0
  113 CONTINUE
      IF (NUMCAT.LE.13) GO TO 116
C
C . . . . . . NUMCAT IS GREATER THAN 13 THEREFORE THE RANGE OF THE
C      VALUES IS DIVIDED INTO 10 CATEGORIES.
C
      XINCMT=RANGE/10.0
      NUMCAT=10
      IFLAG=1
C
C . . . . . . NOW THE NUMBER OF CATEGORIES HAS BEEN CUT TO 10 AND
C      ARRANGED TOGETHER ARE THOSE OBSERVATIONS FALLING WITHIN EACH
C      CATEGORY.
C
      UPLIM=MAXVAL
      DO 115 I=1,10
         UPLIM=UPLIM-XINCMT
         DO 114 J=1,K
            IF (VALUS(J).LE.UPLIM) GO TO 114
            CATEGS(I)=CATEGS(I)+FLOAT(KOUNT(J))
            KOUNT(J)=0
  114    CONTINUE
         RANVAL(I)=UPLIM
  115 CONTINUE
      GO TO 118
  116 J=1
      DO 117 I=1,K
         CATEGS(J)=FLOAT(KOUNT(I))
         RANVAL(J)=VALUS(I)
         J=J+1
  117 CONTINUE
C
C . . . . . . COMPUTE PERCENTAGES.
C
  118 DO 119 I=1,NUMCAT
         CATEGS(I)=(CATEGS(I)/TOTOBS)*100.0
         IF (CATEGS(I).GT.XMAX) XMAX=CATEGS(I)
  119 CONTINUE
      CALL HIST (NUMCAT,CATEGS,RANVAL,XMAX,IFLAG)
      REWIND LU2
      RETURN
C
C . . . . . . FORMATS USED IN THIS SUBROUTINE.
C
  120 FORMAT (1H1,5X,18HLEVEL ANALYSIS FOR/1X,18A4/1H ,5X,8HFOR THE ,I2,
     1A2,21H VARIABLE OF DATA SET,I3)
  121 FORMAT (1H0,10X,4HMEAN,16X,F8.2/1H0,10X,8HVARIANCE,12X,F8.2/1H0,10
     1X,19HSTANDARD DEVIATION,2X,F8.2/1H0,10X,14HSTANDARD ERROR,6X,F8.2/
     21H0,10X,8HSKEWNESS,12X,F8.2/1H0,10X,8HKURTOSIS,12X,F8.2/1H0,10X,4H
     3MODE,16X,F8.2/1H0,10X,6HMEDIAN,14X,F8.2/1H0,10X,5HRANGE,15X,F8.2/1
     4H0,10X,7HMINIMUM,13X,F8.2/1H0,10X,7HMAXIMUM,13X,F8.2)
  122 FORMAT (1H0,40HTHE NUMBER OF OBSERVATIONS IS EQUAL TO 1/1H0,38HTHE
     1REFORE NO HISTOGRAM WILL BE PRINTED)
C
      END
```

```
      SUBROUTINE LOAD (M,K,V,R)
C
C. . . . . . THIS SUBROUTINE (LOAD) IS CALLED BY THE SUBROUTINE
C     (FACTOR) TO COMPUTE A FACTOR MATRIX FROM EIGENVALUES AND
C     ASSOCIATED EIGENVECTORS.
C
      INTEGER I,J,JJ,K,L,M
      REAL R(120),SQ,V(15)
C
      L=0
      JJ=0
      DO 101 J=1,K
         JJ=JJ+J
         SQ=SQRT(R(JJ))
      DO 101 I=1,M
         L=L+1
  101 V(L)=SQ*V(L)
      RETURN
C
      END
      SUBROUTINE MATINV (M,A)
C
C . . . . . . THIS SUBROUTINE (MATINV) IS CALLED BY THE SUBROUTINE
C     (FSCOR) TO COMPUTE THE INVERSE OF MATRIX (A) BY THE GAUSS
C     JORDAN METHOD.
C
      INTEGER I,ICOL,IND(15,2),IPVT(15),IROW,J,K,L,L1,M
      REAL A(15,15),AMAX,PVT(15),SWAP
C
      DO 101 J=1,M
  101 IPVT(J)=0
      DO 114 I=1,M
C
C . . . . . . SEARCH FOR THE PIVOT ELEMENT.
C
         AMAX=0.0
         DO 106 J=1,M
            IF (IPVT(J)-1) 102,106,102
  102       DO 105 K=1,M
               IF (IPVT(K)-1) 103,105,118
  103          IF (ABS(AMAX)-ABS(A(J,K))) 104,105,105
  104          IROW=J
               ICOL=K
               AMAX=A(J,K)
  105       CONTINUE
  106    CONTINUE
         IPVT(ICOL)=IPVT(ICOL)+1
C
C . . . . . . INTERCHANGE THE ROWS TO PUT THE PIVOT ELEMENT ON THE
C     DIAGONAL.
C
         IF (IROW-ICOL) 107,109,107
  107    DO 108 L=1,M
            SWAP=A(IROW,L)
            A(IROW,L)=A(ICOL,L)
  108    A(ICOL,L)=SWAP
  109    IND(I,1)=IROW
         IND(I,2)=ICOL
         PVT(I)=A(ICOL,ICOL)
C
C . . . . . . DIVIDE THE PIVOT ROW BY THE PIVOT ELEMENT.
C
         A(ICOL,ICOL)=1.0
         DO 111 L=1,M
            IF (ABS(PVT(I)).LT.1.0E-30) GO TO 110
            A(ICOL,L)=A(ICOL,L)/PVT(I)
```

```
      GO TO 111
110   A(ICOL,L)=0.0
111   CONTINUE
C
C . . . . . REDUCE NON-PIVOT ROWS.
C
      DO 114 L1=1,M
      IF (L1-ICOL) 112,114,112
112   SWAP=A(L1,ICOL)
      A(L1,ICOL)=0.0
      DO 113 L=1,M
113   A(L1,L)=A(L1,L)-A(ICOL,L)*SWAP
114 CONTINUE
C
C . . . . . INTERCHANGE THE COLUMNS.
C
    DO 117 I=1,M
      L=M+1-I
      IF (IND(L,1)-IND(L,2)) 115,117,115
115   IROW=IND(L,1)
      ICOL=IND(L,2)
      DO 116 K=1,M
        SWAP=A(K,IROW)
        A(K,IROW)=A(K,ICOL)
        A(K,ICOL)=SWAP
116   CONTINUE
117 CONTINUE
118 RETURN
C
    END
    SUBROUTINE ORDER (CCNTRL,JGRP)
C
C . . . . . THIS SUBROUTINE (ORDER) IS CALLED BY THE MAIN PROGRAM
C     (PUBLIC) AND THE SUBROUTINE (GRUPN) TO CONSTRUCT A SINGLE RANK
C     ORDER FROM M VARIABLES WITH NS OBSERVATIONS WITH UNSATISFIED
C     PREFERENCES GIVEN ADDITIONAL WEIGHT.  RANKS ARE DETERMINED
C     BY MAJORITY HIGH OR MOST COMMON LOW.
C
    INTEGER CCNTRL,DATCNT,I,ICON,ID(3),IOBJ,IPRIN,IRANK(15),IWIDE,J
    INTEGER JFLAG,JGRP,JH,JHIGH,JL,JLOW,JX,JZ,KHIGH,KLOW,LLA,LLB,LSAV
    INTEGER LU,LU2,LU3,LU4,LU5,LU6,LU7,LU8,LU9,LU10,M,MAJ,MAXKNT(15)
    INTEGER MINKNT(15),MM,NS,NX,NZ,N1,N2,PR
    REAL DATA(15)
C
    COMMON /INPT/ NS,M,ICON,IPRIN,PR(18),N1,N2,DATCNT
    COMMON /UNIT/ LU,LU2,LU3,LU4,LU5,LU6,LU7,LU8,LU9,LU10,IWIDE
C
    IF (CCNTRL.EQ.1) GO TO 102
    WRITE (LU6,122)
    IF (JGRP.GT.0) GO TO 101
    WRITE (LU6,129) (PR(I),I=1,18),N1,N2,DATCNT
    GO TO 103
101 WRITE (LU6,128) JGRP,(PR(I),I=1,18),N1,N2,DATCNT
    GO TO 103
102 WRITE (LU6,123)
    WRITE (LU6,124) (PR(I),I=1,18),N1,N2,DATCNT
C
C . . . . . SET COUNTERS AND DEFINE MASS STORAGE UNITS.
C
103 LLB=LU7
    LLA=LU3
    JH=M+1
    JL=0
    NX=NS
    DO 104 J=1,M
104 IRANK(J)=0
```

```
C
C. . . . . . BEGINNING OF RANKING LOOP.
C
      MM=M-1
      DO 118 JX=1,MM
         REWIND LLB
         REWIND LLA
         REWIND LU2
         DO 105 J=1,M
            MINKNT(J)=0
  105    MAXKNT(J)=0
C
C. . . . . . READ DATA FROM LU2 OR LLB.
C
         DO 111 I=1,NX
            MAJ=1+NX/2
            IF (I.GT.NS) GO TO 106
            READ (LU2) (ID(J),J=1,3),(DATA(J),J=1,M)
            GO TO 107
  106       READ (LLB) (DATA(J),J=1,M)
C
C. . . . . . DELETE ANY VARIABLES ALREADY RANKED.
C
  107       KHIGH=0
            KLOW=M+1
            DO 110 J=1,M
               IF (IRANK(J).GT.0) GO TO 110
C
C. . . . . . CHECK FOR MOST PREFERRED OR LEAST PREFERRED ITEM.
C
               IF (INT(DATA(J)).LT.KHIGH) GO TO 108
               JHIGH=J
               KHIGH=INT(DATA(J))
  108          IF (INT(DATA(J)).GT.KLOW) GO TO 109
               JLOW=J
               KLOW=INT(DATA(J))
  109          IF (JHIGH.GT.0) GO TO 110
               WRITE (LU6,127) I,J
               REWIND LU2
               RETURN
  110       CONTINUE
            MAXKNT(JHIGH)=MAXKNT(JHIGH)+1
            MINKNT(JLOW)=MINKNT(JLOW)+1
  111    CONTINUE
         KHIGH=0
         KLOW=0
         DO 112 J=1,M
            IF (IRANK(J).GT.0) GO TO 112
            IF (MAXKNT(J).GT.KHIGH) JHIGH=J
            IF (MAXKNT(J).GT.KHIGH) KHIGH=MAXKNT(J)
            IF (MINKNT(J).GT.KLOW) JLOW=J
            IF (MINKNT(J).GT.KLOW) KLOW=MINKNT(J)
  112    CONTINUE
         JFLAG=JHIGH
         IF (KHIGH.GE.MAJ) JH=JH-1
         IF (KHIGH.LT.MAJ) JFLAG=JLOW
         IF (KHIGH.LT.MAJ) JL=JL+1
C
C. . . . . . REVIEW DATA ON LU2 AND LLB TO CHECK AGREEMENT WITH
C        HIGH OR LOW.
C
         REWIND LU2
         REWIND LLB
         REWIND LLA
         NZ=0
         DO 117 I=1,NX
```

```
      IF (I.GT.NS) GO TO 113                                            ORDER103
      READ (LU2) (ID(J),J=1,3),(DATA(J),J=1,M)                          ORDER104
      GO TO 114                                                         ORDER105
  113 READ (LLB) (DATA(J),J=1,M)                                        ORDER106
C                                                                       ORDER107
C . . . . . . IF DATA DOES NOT AGREE WITH HIGH OR LOW, WRITE ON LLA.    ORDER108
C                                                                       ORDER109
  114 IOBJ=0                                                            ORDER110
      DO 116 J=1,M                                                      ORDER111
         IF (IRANK(J).GT.0) GO TO 116                                   ORDER112
         IF (JFLAG.NE.JHIGH) GO TO 115                                  ORDER113
         IF (INT(DATA(J)).GT.JH) IOBJ=1                                 ORDER114
         GO TO 116                                                      ORDER115
  115    IF (INT(DATA(J)).LT.JL) IOBJ=1                                 ORDER116
  116 CONTINUE                                                          ORDER117
      IF (IOBJ.EQ.0) GO TO 117                                          ORDER118
      NZ=NZ+1                                                           ORDER119
      WRITE (LLA) (DATA(JZ),JZ=1,M)                                     ORDER120
  117 CONTINUE                                                          ORDER121
C                                                                       ORDER122
C . . . . . . REVERSE FILE DESIGNATORS AND INCREMENT COUNTERS.          ORDER123
C                                                                       ORDER124
      NX=NZ+NS                                                          ORDER125
      LSAV=LLA                                                          ORDER126
      LLA=LLB                                                           ORDER127
      LLB=LSAV                                                          ORDER128
      IRANK(JFLAG)=JH                                                   ORDER129
      IF (JFLAG.EQ.JLOW) IRANK(JFLAG)=JL                                ORDER130
  118 CONTINUE                                                          ORDER131
      DO 119 J=1,M                                                      ORDER132
      IF (IRANK(J).EQ.0) IRANK(J)=JH-1                                  ORDER133
  119 CONTINUE                                                          ORDER134
      DO 120 J=1,M                                                      ORDER135
  120 IRANK(J)=(M+1)-IRANK(J)                                           ORDER136
      WRITE (LU6,125)                                                   ORDER137
      DO 121 J=1,M                                                      ORDER138
      I=N1-1+J                                                          ORDER139
      WRITE (LU6,126) I,IRANK(J)                                        ORDER140
  121 CONTINUE                                                          ORDER141
      REWIND LU2                                                        ORDER142
      RETURN                                                            ORDER143
C                                                                       ORDER144
C . . . . . . FORMATS USED IN THIS SUBROUTINE.                          ORDER145
C                                                                       ORDER146
  122 FORMAT (1H0)                                                      ORDER147
  123 FORMAT (1H1)                                                      ORDER148
  124 FORMAT (19H ORDER ANALYSIS FOR/1X,18A4/13H FOR VARIABLE,I3,17H THRORDER149
     1OUGH VARIABLE,I3,12H OF DATA SET,I3)                              ORDER150
  125 FORMAT (29H0VARIABLES ORDERED AS FOLLOWS/9H0VARIABLE,5X,4HRANK)   ORDER151
  126 FORMAT (1H ,I6,I10)                                               ORDER152
  127 FORMAT (24H0**** ILLEGAL DATA FOUND/15X,15HOBSERVATION NO.,I10,16HORDER153
     1AND VARIABLE NO.,I4)                                              ORDER154
  128 FORMAT (25H ORDER ANALYSIS FOR GROUP,I4,3H OF/1X,18A4/13H FOR VARIORDER155
     1ABLE,I3,17H THROUGH VARIABLE,I3,12H OF DATA SET,I3)               ORDER156
  129 FORMAT (40H ORDER ANALYSIS FOR THE AVERAGE GROUP OF/1X,18A4/13H FOORDER157
     1R VARIABLE,I3,17H THROUGH VARIABLE,I3,12H OF DATA SET,I3)         ORDER158
C                                                                       ORDER159
      END                                                               ORDER160
      SUBROUTINE PLOT (N,MQ,KF,PFLAG)                                   PLOT 001
C                                                                       PLOT 002
C . . . . . . THIS SUBROUTINE (PLOT) IS CALLED BY THE SUBROUTINES       PLOT 003
C      (EXTRM, FACTOR, AND FSCOR) TO PLOT THE DATA ELEMENTS ON THE      PLOT 004
C      DISK (LU4).                                                      PLOT 005
C                                                                       PLOT 006
      INTEGER I,IA,IB,ID(4),II,III,IIQ,IK,IWIDE,J,JJ,JJJ,JJQ,K,KE,KF    PLOT 007
      INTEGER KG,KJ,KM,KN,KOUNT,L,LBL,LL,LU,LU2,LU3,LU4,LU5,LU6,LU7     PLOT 008
```

```
      INTEGER LU8,LU9,LU10,M,MDLINE,MM,MMQ,MQ,N,NNN,PFLAG,XX(61,67)
      INTEGER XXN(4)
      REAL C,DATA(15),VALUS,X(2500,2),XNUM(7)
C
      COMMON /ARRAY/ VALUS(5000)
      COMMON /LABEL/ LBL(56)
      COMMON /QUAD/ C(9)
      COMMON /UNIT/ LU,LU2,LU3,LU4,LU5,LU6,LU7,LU8,LU9,LU10,IWIDE
C
      EQUIVALENCE (VALUS(1),X(1,1))
C
C . . . . . . READ IN DATA FROM MASS STORAGE.
C
      MMQ=MQ
      IF (MMQ.GT.4) MMQ=4
      NNN=N
      IF (NNN.GT.2500) NNN=2500
      IIQ=MQ-1
      IF (IIQ.GT.3) IIQ=3
      DO 116 I=1,IIQ
         JJQ=I+1
      DO 116 J=JJQ,MMQ
         MDLINE=1
         IF (KF.EQ.2.AND.MQ.LE.9) MDLINE=2
         REWIND LU4
         DO 103 III=1,NNN
            IF (PFLAG.NE.1) GO TO 101
            READ (LU4) (ID(JJJ),JJJ=1,4),(DATA(JJJ),JJJ=1,MQ)
            GO TO 102
  101       READ (LU4) (ID(JJJ),JJJ=1,3),(DATA(JJJ),JJJ=1,MQ)
  102       X(III,1)=DATA(I)
            X(III,2)=DATA(J)
  103    CONTINUE
C
C . . . . . . ESTABLISH SYMBOLS FOR THE LEGENDS AND INITIALIZE PLOT
C        SPACES TO BLANKS.
C
         XXN(1)=LBL(22)
         XXN(2)=LBL(21)
         XXN(3)=LBL(20)
         XXN(4)=LBL(29)
         DO 104 K=1,7
  104    XNUM(K)=K-4
         DO 105 M=1,67
         DO 105 L=1,61
            XX(L,M)=LBL(19)
  105    CONTINUE
C
C . . . . . . DEVELOP MAIN BORDERS FOR PLOT.
C
         DO 106 M=2,60
         DO 106 L=1,61,30
            LL=L+6
            MM=M+6
            XX(M,LL)=LBL(17)
            XX(L,MM)=LBL(17)
  106    CONTINUE
C
C . . . . . . DEVELOP MID LINE BORDERS IF DESIRED.
C
         IF (MDLINE.LE.1) GO TO 108
         KE=20
         IF (MDLINE.EQ.2) KE=INT(10.0*(C(MQ)+.05))*2
         KG=40
         IF (MDLINE.EQ.2) KG=KE
         DO 107 KN=KE,KG,KE
```

```
      KM=31+KN/2
      KJ=KM-KN
      DO 107 MM=KJ,KM,KN
      DO 107 M=KJ,KM
         L=M+6
         LL=MM+6
         XX(M,LL)=LBL(17)
         XX(MM,L)=LBL(17)
  107 CONTINUE
C
C . . . . . . ADD THE PLUS SYMBOL AT WHOLE NUMBER INTERVALS OF PLOT
C     BORDERS.
C
  108 DO 109 M=1,61,10
      DO 109 L=1,61,30
         LL=L+6
         MM=M+6
         XX(M,LL)=LBL(18)
         XX(L,MM)=LBL(18)
  109 CONTINUE
C
C . . . . . . ADD LEGEND FOR VERTICAL (Y) AXIS.
C
      DO 110 M=1,61,10
         XX(M,4)=LBL(29)
         XX(M,3)=LBL(17)
         IF (M.GT.32) XX(M,1)=LBL(16)
  110 CONTINUE
      L=0
      DO 111 M=1,31,10
         L=L+1
         LL=62-M
         XX(M,2)=XXN(L)
         XX(LL,2)=XXN(L)
  111 CONTINUE
C
C . . . . . . PLOT ALL POSSIBLE PAIRS OF VECTORS.
C
      IA=1
      IB=NNN
      IF (KF.NE.3) GO TO 112
      KOUNT=0
      IA=2*I-1
      IB=IA+1
  112 DO 113 IK=IA,IB
         JJ=(X(IK,1)+3.1)*10.0+6.0
         II=(-X(IK,2)+3.1)*10.0
         IF (JJ.LT.7) JJ=7
         IF (JJ.GT.67) JJ=67
         IF (II.LT.02) II=02
         IF (II.GT.61) II=61
         CALL SYMB (XX,II,JJ,KF,IK)
  113 CONTINUE
      IF (KF.NE.3) GO TO 114
      IF (KOUNT.GT.0) GO TO 114
      IA=2*J-1
      IB=IA+1
      KOUNT=1
      GO TO 112
C
C . . . . . . ADD LEGEND TO HORIZONTAL (X) AXIS.
C
  114 WRITE (LU6,117) (XNUM(JJ),JJ=1,7)
      DO 115 M=1,61
  115 WRITE (LU6,118) (XX(M,JJJ),JJJ=1,67)
      WRITE (LU6,119) I,J
```

```
          IF (KF.EQ.1) WRITE (LU6,120)                                  PLOT 141
          IF (KF.EQ.2) WRITE (LU6,121)                                  PLOT 142
          IF (KF.EQ.3) WRITE (LU6,122)                                  PLOT 143
  116 CONTINUE                                                          PLOT 144
      RETURN                                                            PLOT 145
C                                                                       PLOT 146
C. . . . . . FORMATS USED IN THIS SUBROUTINE.                            PLOT 147
C                                                                       PLOT 148
  117 FORMAT (1H1,5X,6(F4.1,6X),F4.1)                                   PLOT 149
  118 FORMAT (2X,67A1)                                                  PLOT 150
  119 FORMAT (10X,6HFACTOR,I3,2X,27HIS ON THE X-AXIS AND FACTOR,I3,2X,16PLOT 151
     1HIS ON THE Y-AXIS)                                                PLOT 152
  120 FORMAT (1H ,10X,30HLETTERS REPRESENT THE VARIABLE)                PLOT 153
  121 FORMAT (1H ,10X,53HNUMBERS REPRESENT NUMBER OF INDIVIDUALS AT EACHPLOT 154
     1 POINT)                                                           PLOT 155
  122 FORMAT (1H ,10X,35HLETTERS REPRESENT EXTREME POSITIONS)           PLOT 156
C                                                                       PLOT 157
      END                                                               PLOT 158
      SUBROUTINE SORT (N,ISORT,AVG)                                     SORT 001
C                                                                       SORT 002
C. . . . . . THIS SUBROUTINE (SORT) IS CALLED BY THE SUBROUTINE         SORT 003
C     (GRUPN) TO SORT THE IDENTIFICATION FIELDS AND FACTOR SCORES FORSORT 004
C     EACH GROUP.  THEN CALCULATE THE AVERAGE FOR THE FACTOR SCORES.    SORT 005
C                                                                       SORT 006
      INTEGER I,II,ISORT,KD,KKD,KKF,KKG,KKK,L,N,NN                      SORT 007
      REAL AVG,SUM,X,XX                                                 SORT 008
C                                                                       SORT 009
      COMMON /ARRAY/ X(1250),KD(3,1250)                                 SORT 010
C                                                                       SORT 011
C. . . . . . SORT OF FACTOR SCORES AND THEIR IDENTIFICATION FIELDS.     SORT 012
C                                                                       SORT 013
      NN=N                                                              SORT 014
      DO 102 KKK=1,N                                                    SORT 015
      IF (NN.EQ.1) GO TO 102                                            SORT 016
      NN=NN-1                                                           SORT 017
      DO 101 I=1,NN                                                     SORT 018
         II=I+1                                                         SORT 019
         IF (X(I).GT.X(II).AND.ISORT.EQ.0) GO TO 101                    SORT 020
         IF (X(I).LT.X(II).AND.ISORT.EQ.1) GO TO 101                    SORT 021
         XX=X(I)                                                        SORT 022
         X(I)=X(II)                                                     SORT 023
         X(II)=XX                                                       SORT 024
         KKD=KD(1,I)                                                    SORT 025
         KKF=KD(2,I)                                                    SORT 026
         KKG=KD(3,I)                                                    SORT 027
         KD(1,I)=KD(1,II)                                               SORT 028
         KD(2,I)=KD(2,II)                                               SORT 029
         KD(3,I)=KD(3,II)                                               SORT 030
         KD(1,II)=KKD                                                   SORT 031
         KD(2,II)=KKF                                                   SORT 032
         KD(3,II)=KKG                                                   SORT 033
  101    CONTINUE                                                       SORT 034
  102 CONTINUE                                                          SORT 035
C                                                                       SORT 036
C . . . . . . SUM THE FACTOR SCORES AND CALCULATE THE AVERAGE FOR THE   SORT 037
C     FACTOR SCORES.                                                    SORT 038
C                                                                       SORT 039
      SUM=0.0                                                           SORT 040
      DO 103 L=1,N                                                      SORT 041
         SUM=SUM+X(L)                                                   SORT 042
  103 CONTINUE                                                          SORT 043
      AVG=SUM/FLOAT(N)                                                  SORT 044
      RETURN                                                            SORT 045
C                                                                       SORT 046
      END                                                               SORT 047
      SUBROUTINE SORT1(K)                                               SORT1001
```

```
C
C . . . . . . THIS SUBROUTINE (SORT1) IS CALLED BY THE SUBROUTINE
C     (LEVEL) TO SORT THE OBSERVATIONS CONTAINED IN ARRAY (VALUS).
C
      INTEGER I,I1,J,K,KK,KOUNT
      REAL SAVE,VALUS
C
      COMMON /ARRAY/ KOUNT(2500),VALUS(2500)
C
      IF(K.LE.1) RETURN
      I=1
  101 I1=I+1
      DO 102 J=I1,K
         IF (VALUS(I).LT.VALUS(J)) GO TO 102
         SAVE=VALUS(J)
         VALUS(J)=VALUS(I)
         VALUS(I)=SAVE
         KK=KOUNT(J)
         KOUNT(J)=KOUNT(I)
         KOUNT(I)=KK
  102 CONTINUE
      I=I+1
      IF(I.EQ.K) RETURN
      GO TO 101
C
      END
      SUBROUTINE SYMB (XX,I,J,KF,IK)
C
C . . . . . . THIS SUBROUTINE (SYMB) IS CALLED BY THE SUBROUTINE
C     (PLOT) TO INSERT APPROPRIATE CHARACTERS AND SYMBOLS INTO THE
C     ARRAY (XX) CONTAINING THE PLOT.
C
      INTEGER I,IALPHA(26),IK,ISYM(11),J,K,KF,KK,LBL,XX(61,67)
C
      COMMON /LABEL/ LBL(56)
C
      EQUIVALENCE (ISYM(1),LBL(20)),(IALPHA(1),LBL(31))
C
C . . . . . . INSERT APPROPRIATE ALPHABETIC CHARACTERS TO REPRESENT
C     VARIABLES.
C
      IF (KF.EQ.2) GO TO 101
      XX(I,J)=IALPHA(IK)
      GO TO 105
C
C . . . . . . INSERT APPROPRIATE PLOTTING CHARACTER.
C
  101 IF (XX(I,J).EQ.ISYM(11)) GO TO 105
      IF (XX(I,J).LT.ISYM(10).OR.XX(I,J).GT.ISYM(9)) GO TO 104
      DO 102 K=1,10
         KK=K+1
         IF (XX(I,J).EQ.ISYM(K)) GO TO 103
  102 CONTINUE
  103 XX(I,J)=ISYM(KK)
      GO TO 105
  104 XX(I,J)=ISYM(1)
  105 RETURN
C
      END
      SUBROUTINE VARMX (M,K,A,H,D,F)
C
C . . . . . . THIS SUBROUTINE (VARMX) IS CALLED BY THE SUBROUTINE
C     (FACTOR) TO PERFORM ORTHOGONAL ROTATIONS OF A FACTOR MATRIX.
C
      INTEGER I,II,J,K,K1,L,LB,LL,L1,L2,L3,L4,M,NC,NV
      REAL A(225),AA,B,BB,CC,CONS,COSP,COST,COS2T,COS4T,CTN4T,D(15),DD
```

```
      REAL EPS,F(15),FFN,FN,H(15),SINP,SINT,SIN2T,SIN4T,T,TAN4T,TV(51)
      REAL TVLT,U
C
      EPS=0.00116
      TVLT=0.0
      LL=K-1
      NV=1
      NC=0
      FN=M
      FFN=FN*FN
      CONS=0.707106781
C
C . . . . . . CALCULATE ORIGINAL COMMUNALITIES.
C
      DO 101 I=1,M
         H(I)=0.0
      DO 101 J=1,K
         L=M*(J-1)+I
  101 H(I)=H(I)+A(L)*A(L)
C
C . . . . . . CALCULATE NORMALIZED FACTOR MATRIX.
C
      DO 102 I=1,M
         H(I)=SQRT(H(I))
      IF(H(I).LE.1.0E-30) H(I)=1.0E-30
      DO 102 J=1,K
         L=M*(J-1)+I
  102 A(L)=A(L)/H(I)
      GO TO 104
C
C . . . . . . CALCULATE VARIANCE FOR FACTOR MATRIX.
C
  103 NV=NV+1
      TVLT=TV(NV-1)
  104 TV(NV)=0.0
      DO 106 J=1,K
         AA=0.0
         BB=0.0
         LB=M*(J-1)
         DO 105 I=1,M
            L=LB+I
            CC=A(L)*A(L)
            AA=AA+CC
  105       BB=BB+CC*CC
  106 TV(NV)=TV(NV)+(FN*BB-AA*AA)/FFN
      IF (NV-51) 107,128,128
C
C . . . . . . PERFORM CONVERGENCE TEST.
C
  107 IF ((TV(NV)-TVLT)-(1.E-7)) 108,108,109
  108 NC=NC+1
      IF (NC-3) 109,109,128
C
C . . . . . . ROTATION OF TWO FACTORS CONTINUES UP TO THE STATED NUMBER.
C
  109 DO 127 J=1,LL
         L1=M*(J-1)
         II=J+1
C
C . . . . . . CALCULATE NUMERATOR AND DENOMINATOR.
C
      DO 127 K1=II,K
         L2=M*(K1-1)
         AA=0.0
         BB=0.0
         CC=0.0
```

```
      DD=0.0
      DO 110 I=1,M
         L3=L1+I
         L4=L2+I
         U=(A(L3)+A(L4))*(A(L3)-A(L4))
         T=A(L3)*A(L4)
         T=T+T
         CC=CC+(U+T)*(U-T)
         DD=DD+2.0*U*T
         AA=AA+U
  110 BB=BB+T
      T=DD-2.0*AA*BB/FN
      B=CC-(AA*AA-BB*BB)/FN
C
C . . . . . . COMPARISON OF NUMERATOR AND DENOMINATOR.
C
      IF (T-B) 113,111,117
  111 IF ((T+B)-EPS) 127,112,112
C
C . . . . . . NUMERATOR + DENOMINATOR IS GREATER THAN OR EQUAL TO THE
C     TOLERANCE FACTOR.
C
  112 COS4T=CONS
      SIN4T=CONS
      GO TO 120
C
C . . . . . . NUMERATOR IS LESS THAN DENOMINATOR.
C
  113 TAN4T=ABS(T)/ABS(B)
      IF (TAN4T-EPS) 115,114,114
  114 COS4T=1.0/SQRT(1.0+TAN4T*TAN4T)
      SIN4T=TAN4T*COS4T
      GO TO 120
  115 IF (B) 116,127,127
  116 SINP=CONS
      COSP=CONS
      GO TO 125
C
C . . . . . . NUMERATOR IS GREATER THAN DENOMINATOR.
C
  117 CTN4T=ABS(T/B)
      IF (CTN4T-EPS) 119,118,118
  118 SIN4T=1.0/SQRT(1.0+CTN4T*CTN4T)
      COS4T=CTN4T*SIN4T
      GO TO 120
  119 COS4T=0.0
      SIN4T=1.0
C
C . . . . . . DETERMINE COS THETA AND SIN THETA.
C
  120 COS2T=SQRT((1.0+COS4T)/2.0)
      SIN2T=SIN4T/(2.0*COS2T)
      COST=SQRT((1.0+COS2T)/2.0)
      SINT=SIN2T/(2.0*COST)
C
C . . . . . . DETERMINE COS PHI AND SIN PHI.
C
      IF (B) 122,122,121
  121 COSP=COST
      SINP=SINT
      GO TO 123
  122 COSP=CONS*COST+CONS*SINT
      SINP=ABS(CONS*COST-CONS*SINT)
  123 IF (T) 124,124,125
  124 SINP=-SINP
C
```

```
C . . . . . . PERFORM ROTATION.                                        VARMX140
C                                                                      VARMX141
  125     DO 126 I=1,M                                                 VARMX142
             L3=L1+I                                                   VARMX143
             L4=L2+I                                                   VARMX144
             AA=A(L3)*COSP+A(L4)*SINP                                  VARMX145
             A(L4)=-A(L3)*SINP+A(L4)*COSP                              VARMX146
  126     A(L3)=AA                                                     VARMX147
  127 CONTINUE                                                         VARMX148
      GO TO 103                                                        VARMX149
C                                                                      VARMX150
C . . . . . . DENORMALIZE VARIMAX LOADINGS.                            VARMX151
C                                                                      VARMX152
  128 DO 129 I=1,M                                                     VARMX153
      DO 129 J=1,K                                                     VARMX154
         L=M*(J-1)+I                                                   VARMX155
  129 A(L)=A(L)*H(I)                                                   VARMX156
C                                                                      VARMX157
C . . . . . . CHECK ON COMMUNALITIES.                                  VARMX158
C                                                                      VARMX159
      NC=NV-1                                                          VARMX160
      DO 130 I=1,M                                                     VARMX161
  130 H(I)=H(I)*H(I)                                                   VARMX162
      DO 132 I=1,M                                                     VARMX163
         F(I)=0.0                                                      VARMX164
         DO 131 J=1,K                                                  VARMX165
            L=M*(J-1)+I                                                VARMX166
  131    F(I)=F(I)+A(L)*A(L)                                           VARMX167
  132 D(I)=H(I)-F(I)                                                   VARMX168
      RETURN                                                           VARMX169
C                                                                      VARMX170
      END                                                              VARMX171
```