variables need not be adjusted unless the problem exceeds eight factors. The variable FORMAT array FMT may be adjusted for the size of the actual variable FORMAT used.

The computational technique presented in Table 1 allows the researcher maximum flexibility in the analysis of repeated-measures designs. The program presented allows analysis of those data sets in which, for reasons unrelated to the research, the number of subjects is not the same in all between-subject groups.

The computation of regression estimate factor scores for singular and nonsingular data

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Let $\tilde{Z}$ be an N by p matrix of p standard score observations on N people such that $\tilde{Z}'\tilde{Z} = \tilde{R}$, the intercorrelation matrix of the p variables. Let $\tilde{A}$ be an oblique primary structure, or oblique reference pattern or an orthogonal structure matrix, p by m , where m designates the number of factors. Assume $\tilde{R}$ to be either singular or nonsingular. Resolve $\tilde{R}$ completely into p eigenvalues $\tilde{M}^2$ and associated unit length eigenvectors $\tilde{Q}$ such that $\tilde{R} = \tilde{Q}\tilde{M}^2\tilde{Q}'$. Then, take the nonzero eigenvalues of $\tilde{M}^2$ and compute their reciprocals. Call the matrix of nonzero reciprocals $\tilde{M}^{-2*}$. Then the inverse of a nonsingular intercorrelation matrix, $\tilde{R}^{-1}$, is just $\tilde{Q}\tilde{M}^{-2*}\tilde{Q}'$. However, for a singular matrix $\tilde{R}$, the product $\tilde{Q}\tilde{M}^{-2*}\tilde{Q}'$ has all of the algebraic properties of a generalized inverse (Graybill, 1969) and is just $\tilde{R}^-$. Thus, the regression factor scores F (Mulaik, 1972) may be generally defined as

$$F = \tilde{Z}\tilde{Q}\tilde{M}^{-2*}\tilde{Q}'\tilde{A}$$

A program for latent partition analysis

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Wiley (1967) has developed a multivariate procedure for the analysis of categorical or nominal data. His procedure, latent partition analysis, was formulated to study the "relationships" between two or more categorizations of the same set of items. Given certain assumptions, his procedure is *analogous* to an independent cluster solution of an iterated principal axis factor solution.

Input. Data that are determined by individual's sortings or placings of items into particular categories are used as input; ordinal data may also be thought of within the framework of categorical data (Likert-type data).

Output. Program output includes such matrices as the estimated latent category matrix (ELC) and the symmetric confusion matrix. The ELC matrix, analogous to a primary factor pattern matrix, indicates item membership in "hypothetical categories," assuming the hypothetical categories are mutually exclusive. The

REFERENCES

- Clifford, T. Simplified computational programming for analysis-of-variance designs with correlated observations. *Psychological Bulletin*, 1968, 69, 439-440.
Hartley, H. O. Analysis of variance. In A. Ralston and H. S. Wilf (Eds.), *Mathematical methods for digital computers*. New York: Wiley, 1960. Pp. 221-230.
IBM Scientific Subroutine Package. White Plains: IBM, 1968, Manual H20-0205-3.
Winer, B. J. *Statistical principles in experimental design*. (2nd ed.) New York: McGraw-Hill, 1971.

regardless of either the obliquity of the factors or the nature of the determinant of the variable intercorrelation matrix.

A series of subroutines have been written to compute factor scores according to this general algorithm. The subroutines require as input, the matrices $\tilde{A}$, $\tilde{R}$, and $\tilde{Z}$. To facilitate storage, $\tilde{Z}$ and $\tilde{R}$ are initially required to compute the product $\tilde{Z}\tilde{Q}\tilde{M}^{-2*}\tilde{Q}'$ which is stored on a scratch tape so that it may be used repeatedly with a variety of $\tilde{A}$ matrices regardless of whether or not $\tilde{R}$ is singular.

The subroutines are written in FORTRAN IV utilizing the principles of dynamic storage and single subscripting. They have been implemented on the IBM Model 370-168 G-level compiler as well as certain RCA, CDC, and UNIVAC models.

Routine listings as well as documentation illustrative data and computations are available from the author.

REFERENCES

- Graybill, F. A. *Introduction to matrices with applications in statistics*. Belmont: Wadsworth Publishing Company, 1969.
Mulaik, S. A. *The foundations of factor analysis*. New York: McGraw Hill, 1972.

off-diagonal elements of the confusion matrix, analogous to a primary intercorrelation matrix, indicate the probability of two distinct items from two distinct hypothetical categories being placed in the same category by a particular sorter.

Capacity. The program requires 38094 bytes of core as it is presently written. Presently programmed in FORTRAN IV to accommodate 40 items and 20 hypothetical categories with no limit on the number of sorters the capacity is easily enlarged by changing one statement in the program. With the use of an IBM 370-168 G-level compiler, a test problem of 10 items, 14 sorters and three hypothetical categories required 5 sec to compile and run.

Availability. Copies of this paper, a source listing, and documented output from an illustrative example can be obtained by writing to Richard J. Hofmann, Department of Educational Psychology, Miami University, Oxford, Ohio 45056.

REFERENCES

- Wiley, D. E. Latent partition analysis. *Psychometrika*, 1967, 32, 183-193.