Behavior Research Methods & Instrumentation
1976, Vol. 8 (3), 313

MAV: A FORTRAN program for multivariate analysis of variance, profile analysis, and multiple comparisons

C. DENNIS CARROLL
School of Education
University of California, Riverside, California 92502

Description. Multivariate analysis of variance is a statistical procedure for evaluating the effects of variation in independent categorical variables with respect to two or more continuous dependent variables. The arrangement of independent categorical variables corresponds to distinct groups of subjects. A linear composite of the dependent variables is formed such that the mean composite scores of the groups are maximally different. Differences in the groups' mean composite scores are examined in relation to chance fluctuation by using Wilks' likelihood (Morrison, 1967) or greatest characteristic root (Harris, 1975) criteria.

If the dependent variables are of equivalent scale, the profiles of the groups may be examined for parallelism, level, and flatness (Harris, 1975). In most cases, equivalence of scale refers to equality of the number of test items and equivalent scoring. Equivalent scales are often employed in longitudinal studies as repeated or alternate form measurements. A group's profile is the dependent variable response trend displayed by the group. Parallelism, level, and flatness hypotheses correspond to hypotheses incorporated in a univariate repeated measures analysis of variance for one between and one within independent variable. Parallelism corresponds to the interactive univariate effect and concerns differentially shaped profiles. Level corresponds to the between univariate effect and flatness corresponds to the within univariate effect. That is, level indices reflect the extent of group differences for the sum of the dependent variables. Finally, flatness concerns the linearity of the profile formed after pooling all the groups.

Multivariate multiple comparison procedures are necessary for the comparison of a subset of the groups' means, within an independent variable, on some linear composite of dependent variables. Simultaneous confidence intervals as proposed by Roy and Bose (1953) are appropriate for multivariate multiple comparisons. Harris (1975) delineated the critical values appropriate for a priori and post hoc comparisons.

MAV input. Data input to MAV includes the subjects' dependent variable observations. User-supplied variable format and extensive transformation of input observations allow great flexibility of input. Analysis option and parameter specification are decoded with error identification to facilitate program use by the novice. An optional input to MAV consists of sets of user-supplied multiple comparison coefficients.

MAV output. For each independent variable and interaction of independent variables, MAV displays Wilks' likelihood and greatest characteristic root indices. Associated degrees of freedom and p values are also listed. This output is generated based upon the procedures cited by Harris (1975).

The linear composite of dependent variables, constructed to distinguish between the groups, is output in two forms. The raw form may be employed for construct interpretations. The standardized form facilitates examination of each dependent variable's contribution to variation in the composite.

Univariate analysis of variance source tables for each dependent variable are also displayed. These source tables consist of values for degrees of freedom, sums of squares, mean squares, F ratios, and univariate p values for each effect. These analyses can be very useful for post hoc examination of individual dependent variables using critical values based upon the greatest characteristic root distribution (Harris, 1975).

At the user's discretion, MAV output includes means and variance-covariance matrices for each group. Profile analysis indices for parallelism, level, and flatness may be requested. Finally, multiple comparisons, based upon user-supplied contrast coefficients, are available. MAV employs a modification of the simultaneous confidence interval approach proposed by Roy and Bose (1953) for multiple comparisons. This modification results in the generation of the minimum level of confidence required for the interval to exclude zero.

Operation. The program is written in FORTRAN IV for the IBM 360/50. MAV may be employed for at most three cross-classified independent variables. The maximum number of dependent variables is 20. Equal numbers of subjects per group is not required, but proportionality is required for analyses with two or three independent variables.

Availability. A program listing is available from the author. Source decks and user's manuals are also available at cost.

REFERENCES

HARRIS, R. J. *A primer of multivariate statistics.* New York: Academic Press, 1975.

MORRISON, D. F. *Multivariate statistical methods.* New York: McGraw-Hill, 1967.

ROY, S. N., & BOSE, R. C. Simultaneous confidence interval estimation. *Annals of Mathematical Statistics,* 1953, **24**, 220-238.