Program Abstracts/Algorithms

N-Way MANOVA: A BASIC program for minicomputers

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Although there are several programs available which will perform an N-way Multivariate Analysis of Variance (MANOVA), many are expensive and difficult to obtain. More importantly, most require a relatively large amount of core, more than is available on many computer systems. The present program was designed for minicomputers; not only are the core requirements minimal, but no peripheral devices other than a Teletype are necessary. The program computes a MANOVA for either a one-way (between-groups) design or a more complicated N-way factorial arrangement of the independent variables. The solution requires equal sample sizes in the groups or cells.

Computer and Language. The program is written for an interactive BASIC compiler with matrix operations, variable logical units, and optional LET statements. It will run with little or no modification on any computer with an interactive BASIC compiler that allows the matrix operations statements. An Interdata Model 70 minicomputer with 32K bytes of core storage was used for program development.

Core and Time Requirements. The program has 100 statements, aside from the REM statements, and takes up 1,810 bytes in core. The data storage is flexible, but, as an example, a 2 by 3 MANOVA with five dependent measures requires an additional 1,012 bytes. Running time is determined primarily by input/output time. On our system the computation time for the above design with 10 subjects per cell is only 9 sec. It takes about 4 min, however, to print the results via Teletype.

Input. The first record unit contains the number of subjects per cell, the number of independent variables, the number of dependent variables, the number of cells, and the logical input unit for the data. The data is then entered in lexicographic order, as in the BMD ANOVA series (Dixon, 1968). All of the data from the first subject in Cell 1 is input, followed by the data from the first subject in Cell 2, and so on. Data are read in as replications, where a replication consists of one subject from each cell of the design. Replications are read in

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Table 1
Input Required for a 2 by 3 Factorial Design

"INPUT NO. OF SUBJECTS PER CELL. NO. OF INDEPENDENT VARIABLES. NO. OF DEPENDENT MEASURES, NO. OF CELLS, AND THE LOGICAL UNIT FOR DATA INPUT"*
10, 2, 5, 6, 5
"INPUT DATA"
(Data from each of the 60 subjects should be entered in lexicographic order, one replication followed by another.)
Program prints pooled within-groups deviation cross-product matrix.
"DEGREES OF FREEDOM FOR EFFECT 1"
1
"INPUT CONTRAST VECTOR 1"
1, 1, 1, -1, -1, -1
Program prints the results for the A effect.
"DEGREES OF FREEDOM FOR EFFECT 2"
2
"INPUT CONTRAST VECTOR 1"
1, -1, 0, 1, -1, 0
"INPUT CONTRAST VECTOR 2"
1, 1, -2, 1, 1, -2
Program prints results for the B effect.
"DEGREES OF FREEDOM FOR EFFECT 3"
2
"INPUT CONTRAST VECTOR 1"
1, -1, 0, -1, 1, 0
"INPUT CONTRAST VECTOR 2"
1, 1, -2, 2, -1, -1
Program prints the results for the interaction and the table of cell means.

*Messages in quotes are as printed by the Teletype.

one at a time, until as many replications as there are subjects per cell have been read.

No further information is required if the design is a simple one-way MANOVA. For more complex designs, the user must supply an appropriate set of contrast vectors for each effect tested. Each contrast vector contains the coefficients for a component on one degree of freedom of the effect being tested. There will be one coefficient for each cell in the design. For a given effect, the user must first input the degrees of freedom. The program then requests as many contrast vectors as there are degrees of freedom for the effect. For information on how to construct a set of coefficients corresponding to the usual Fisherian partitioning of the variance, see Edwards (1950) or Namboodiri, Carter, and Blalock (1975).

Output. The program reports the following output: The pooled within-groups deviation cross-product matrix, univariate F tests, Wilk's lambda, Rao's F statistic, cell means for each dependent measure. An example of the input required for the program is shown in Table 1. The design is a 2 by 3 factorial with 10 subjects per cell and five dependent measures. The six cells are ordered as follows, with the first subscript representing the level of variable A and the second subscript

representing the level of variable B: 1,1; 1,2; 1,3; 2,1; 2,2; 2,3.

Availability. Requests for a listing of the program should be addressed to David M. Lane, Department of Psychology, Tulane University, New Orleans, Louisiana 70118. If a paper-tape copy of the program is also desired, it will be provided at no cost.

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