Two-factor analysis of variance with one nested factor: A BASIC program for microcomputers

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In a complete factorial design, all levels of a given variable are crossed with all levels of every other variable; all possible treatment combinations are employed. The factorial design is popular because it provides an assessment of the effects of two or more independent variables simultaneously, as well as their combined or interaction effects.

Although popular among experimenters, the complete factorial design is not always the most appropriate for an experimental situation. For example, conditions sometimes exist in which each level of Factor B cannot be combined with each and every level of Factor A. Such a situation is illustrated in Table 1 and represents what is commonly known as a simple nested design. Note that entirely different levels of Factor B are associated with each level of Factor A. That is, levels of Factor B are "nested" under the A factor.

The nested design is limited, since interactions cannot be assessed. In fact, the two-factor experiment in which Factor B is nested under Factor A should not be employed if an interaction is suspected (Winer, 1962). However, the constraints of the nested design notwithstanding, there are situations in which it is the design of choice.

Although computational procedures for the nested design are available for hand calculation (Ferguson, 1976; Winer, 1962), this type of analysis is generally not part of large computer statistical packages. For example, BMD (Dixon, 1974) does not provide procedures for nested designs. SPSS, until recently, did not handle a nested design (Nie, Hull, Jenkins, Steinbrenner, & Bent, 1975). However, the SPSS MANOVA command, now available to most SPSS sites, allows nesting. The purpose of the present program is to provide the microcomputer user with a BASIC program of the simple nested design.

The program is based on the computational procedures of Ferguson (1976). It assumes that Factor A (main effect) is fixed, and it allows the user to specify whether the B (nested) factor is fixed or random.

Input. The program requires that the first DATA statement contain the number of levels of Factor A, the number of levels of Factor B nested under a level of A, and the number of scores for each B(A) group. The program further requires that score data be placed in DATA statements in group order, starting with the levels of B nested under A1. For example, the

Table 1
Sample Data for Simple Nested Design

A1			A2		
B1	B2	B3	B4	B5	B6
5	11	11	4	10	6
6	14	12	1	12	11
4	16	18	7	18	12
3	22	25	8	15	20
9	17	19	6	14	10

Note—Sample data are from Ferguson (1976, p. 342).

Table 2
Sample Output (With Both A and B Factors "Fixed")

Source	Sum of Squares	df	Mean Square	F
A (Main Effect)	48.13	1	48.13	2.97
B (Nested Factor)	617.73	4	153.93	9.48
Within Groups	389.60	24	16.23	
Total	1053.47	29		

Note—If Factor A is fixed and Factor B is random, the appropriate error term for the A effect is the Factor B mean square.

sample data from Table 1 show two levels of A with three levels of B nested under each. Accordingly, the sample data for B1(A1) are listed first, followed by those for B2(A1), B3(A1), B4(A2), B5(A2), and B6(A2).

Program Language and Requirements. The program is written in Radio Shack Level II BASIC and requires a minimum of 2.3 KB of RAM, exclusive of data. An APPLESOFT BASIC version differs in output format statements (APPLESOFT BASIC does not have the PRINT USING option) and requires approximately 3 KB of RAM.

Output. Sample output is presented in Table 2. A complete summary ANOVA table is provided.

Availability. A listing and sample run of either the Radio Shack or Apple versions may be obtained by writing to the author at the following address: Social Science Group, Widener University, Chester, Pennsylvania 19013.

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