

UNIVARAN: A universal analysis of variance program

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Recently, programs for analyses of variance have been published for special designs and a limited number of factors (see Flexser, 1982, and Galla, 1982). The universal analysis of variance program described here was designed for a general number of factors and factor levels and can process various experimental designs. It allows the analysis of all completely randomized designs with and without nested factors as well as randomized block designs (repeated measures). In addition, an unweighted-means analysis may be performed for completely randomized designs with unequal cell frequencies. Some special Latin-square designs can also be analyzed. The program was originally developed in BASIC for a microcomputer but is also available as a FORTRAN IV version.

Method. The method is based on the calculus for a general k -factor experiment by Hartley (1960). This calculus performs a sequence of sigma and delta operations, from which sums and deviations for the various factor levels are obtained. The final mean square operator produces the sums of squares for the 2^k-1 variance components. The sums of squares, degrees of freedom, and mean squares are computed for all factors and their combinations. In order to keep the program flexible for various types of designs, such as plans with fixed and random factors, repeated measures, and nested designs, no F statistics are determined. The F tests have to be constructed by the user according to his or her particular design from the proper variance components of the program output.

In the case of repeated measures, an additional factor for subjects has to be introduced, with as many levels as there are different subjects per block. The cell frequencies have to be set equal to 1 in this case. The same procedure applies for nested designs.

Input. The user has to specify the input device, which may be keyboard, cassette, disk, or READ statement. The control data are then read from the device specified: the number of factors, their levels, and the number of subjects per cell. Next follow the experimental data in a hierarchical order, with the index of last factor changing first.

Output. The output consists of the sums of squares, degrees of freedom, and mean squares for each of the 2^k-1 variance components, that is, for factors and

their combinations. The means for the summary tables of the effects are output as well. The information pertaining to the single variance components is accessed from the single-step mode. In addition, a complete analysis of variance table is built up at the end of the program. The user may skip the single-step mode and switch directly to the output of the complete table. For a completely randomized design with cell frequency greater than 1, cell means and variances are given. The output may be directed to the display, the printer, or the floppy disk.

Limitations. Although the numerical procedures do not impose any limitations on the number of factors or their levels, practical limitations such as computer memory and computing time have to be considered. The number of cells that can be processed by the program depends on the number of factors. If all remarks are removed, it would be possible to handle problems with up to 7 factors and 2 levels each on a microcomputer such as the TRS-80 with 48-KB memory. In a four-factor design, the number of cells is limited to about 1,000 for the configuration mentioned above, whereas about 1,600 cells can be treated with two factors. Group size per cell, however, has no significant influence on the number of cells admissible.

Program Language and Requirements. The BASIC program is written in Level II BASIC for the TRS-80 Models I and III. The program text without variables occupies approximately 16 KB of RAM, which reduces to 10 KB if all remarks are removed. After proper modifications, the program should also work on other machines with MICROSOFT BASIC and on tape-based systems. A minimum of 16 KB of free memory in BASIC is recommended for a reasonable use of the program. The FORTRAN version is written in FORTRAN IV and was tested and run on a PDP-11/34 with RSX-11M operating system and on a TRS-80 with MICROSOFT FORTRAN 80.

Availability. Source code listings in FORTRAN IV as well as in BASIC for the TRS-80 and a user's guide with numerical examples are available on request at no cost from either author at the Department of Psychology, Technical University of Brunswick, D-3300 Braunschweig, West Germany.

REFERENCES

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