PROGRAM ABSTRACTS/ALGORITHMS

FAC1: An interactive FORTRAN program to calculate principal factor loadings

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Recently, Schmitt (1977) produced a BASIC program to conduct a factor analysis by means of the centroid method; the program allows input of raw data or of a correlation matrix. Schmitt reports, "a common feature of factor analysis programs is their development in languages such as FORTRAN for use on large computer systems. In many instances, less formal and less expensive access would be desirable; laboratory minicomputers afford that accessibility" (1977, p. 302). This, unfortunately, is not the entire story.

In many installations, to load a binary program already compiled under FORTRAN is no more expensive in terms of storage space than it is to read a large source program in BASIC and then compile the source program. In Schmitt's (1977) centroid program, there are 123 lines of source code. Usually, FORTRAN compilers are better at optimizing code and will produce a less wasteful object program than a BASIC compiler. Frequently, it is as easy, if not easier, for a user to run an on-line FORTRAN program as it is to run an on-line BASIC program, if both are library programs. In many circumstances, particularly for small-scale programs, BASIC is clearly superior, but Schmitt is writing of a situation where FORTRAN could be superior. At my installation, to use Schmitt's program, one first needs to load the BASIC interpreter and then call the centroid program; to use FAC1, one only needs to call the program. If FORTRAN on-line is not accessible, one must use BASIC.

The Program. FAC1 is a FORTRAN program to conduct a principal factor analysis by means of a matrix deflation method. This is an adaptation of Veldman's (1967) subroutine SEVS (see also subroutine ITER S in Cooley and Lohnes, 1971). In terms of efficiency of storage, this routine is better than the centroid method portrayed by Schmitt (1977) in that this method requires only one matrix, which is destroyed in processing; the centroid method uses three matrices. In addition, as Bennett and Bowers note, "the important differences between the centroid method of factor analysis and principal factor analysis is that the latter extracts the maximum amount of variance due to each

factor at each stage, whereas the centroid method only achieves this approximately; in other words, it is less efficient" (1976, p. 36).

Compared to popular "Jacobi" methods for diagonalization in principal factor analysis, the coding for the deflation method is much shorter; and, in addition, it allows the sequential extraction of factors in order of size, so the extraction can be stopped when the user feels that there are sufficient factors. FAC1 only takes matrix input and can be used as a stand-alone principal component analysis program for matrices other than correlation matrices.

On-Line Input. On-line input (by prompt) includes (1) numbers of variables, (2) matrix row by row, and (3) eigen values and latent roots. Each eigen value or latent root is output and the user is asked if she/he wishes to extract the next root.

On-Line Output. On-line output includes (1) a check of matrix input, (2) roots (see On-Line Input), (3) factor loadings, and (4) communalities.

Development and Implementation. FAC1 is used as an introduction to factor analysis and coupled with some text, such as Bennett and Bowers (1976), and loadings are input into other programs for further elaboration (e.g., packages such as SPSS or PMMD, although we have one on-line Varimax rotation routine and others are being developed). FAC1 runs under the MAXIMOP system on an ICL 1902T (64K) with 28 on-line channels. The language used, apart from the use of primes with text, is ANSI FORTRAN.

Availability. A source listing, together with a test run, can be obtained (at no charge) from the author, G. J. Boris Allan, at the Department of Social Science, Manchester Polytechnic, Aytoun Street, Manchester M1 3GH, England.

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