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## Nonparametric Comparison of Exponential Growth Curves

A program to compare exponential growth curves via randomization tests has been developed for the one-way analysis-of-variance situation. Exponential growth curves of the form  $Y = a - b \exp(-gt)$  are first fit to each individual's longitudinal data. The parameters from each individual's curve are then input into the randomization program.

The randomization program is written in SAS IML and uses the procedure developed by Zerbe (1979) to compare mean growth curves over a prespecified interval of time. This procedure was adapted specifically for computing exponential growth curves. Because derivatives of exponential growth curves are also exponential curves, parameters from differentiated curves can be input into the program to compare velocity and acceleration curves. This program requires that the exponential growth curves have already been fit to each individual's data; however, example SAS statements for using PROC NONLIN are also provided for estimating

an individual's parameters.

These programs are currently running on a VAX VMS operating system. A listing is available from us at no charge. The randomization program should run on mainframes and microcomputers that have SAS IML, although minor modifications for reading input data may be needed among different operating systems.

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## SAS/IML: An Interactive Matrix Language

SAS Institute offers the SAS/IML product, featuring an interactive matrix language called IML. This language is the interactive reincarnation of the MATRIX procedure, which has been a popular language for implementing custom statistical methods since 1976.

Matrix languages allow you to express matrix calculations directly, rather than writing iteration loops or calling subroutines. For example, if you want to do a least squares regression problem with notation close to that from a textbook, you could do it with a statement like

$$B = INV(X' * X) * X' * Y; .$$

SAS/IML is available in Version 5 of the SAS System for mainframes and minicomputers, and in Version 6.02 for PC's (see SAS Institute 1985a,b). A new release (6.03) for PC's will be forthcoming and will offer many new features. In addition to supporting all of the matrix programming facilities of PROC MATRIX, IML features the following:

1. IML is fully interactive. You can execute each statement immediately.
2. IML supports modularity. You can package statements into modules and call them.
3. IML has a cleaner (and incompatible) notation for division, matrix literals, subscripts, and various other commands, as compared with PROC MATRIX.

4. IML supports more I/O data processing features than MATRIX.

5. IML (Version 6) supports windows that can be used to implement menus, entry screens, and display screens easily.

6. IML (Version 6) supports input and output to external files with statements similar to those for the SAS data step.

7. IML supports workspace files to store matrices. In Version 6 modules can also be stored.

8. IML supports device graphics operators (Version 5 and Version 6.03). These operators include lines, points, polygon fill, characters in font, and others.

9. IML supports user-written functions (in PL/1 for Version 5, in C for Version 6.03).

10. In Version 6, IML supports program interrupts.

Sample IML programs are available to do nonlinear equation solving, linear regression with diagnostics, nonlinear regression, factor analysis, categorical linear models, logistic and probit regression, response-surface modeling, iterative proportional fitting, linear programming, autoregressive-integrated-moving-average time series modeling, and scatter-matrix plots.

SAS/IML is one of several add-on products to SAS. PROC MATRIX is being phased out. PROC MATRIX came automatically with older versions for SAS for MVS and CMS. In Version 5, PROC MATRIX was withdrawn from the User's Guide, although the procedure continues to work and documentation is still available in Technical Report P-135.