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NASA TECH BRIEF

Marshall Space Flight Center

Method For Nonlinear Exponential Regression Analysis

The problem:

The general procedure in regression analysis is to take partial derivatives of a specific model-dependent minimizing function. These partial derivatives are taken with respect to each of the unknown model parameters. If the set of equations obtained by setting these partial derivatives equal to zero can be solved by the usual algebraic methods, the analytical representation of experimental data is accomplished. However, if these equations are transcendental in one or more of the unknown parameters, they cannot be solved by the usual algebraic methods.

The solution:

Two highly flexible computer programs were developed according to two general types of exponential models. One concerns a single exponential and the sum of exponentials without a constant, and the other concerns the sum of exponentials with a constant included.

How it's done:

The processes of particular interest in this program are those that can be described by decaying exponential forms. A mathematical model that contains more than one exponential term results in a set of transcendental normal equations if conventional forms of regression analysis are used. Thus, one usually resorts to iterative methods that require initial estimates for the parameters. The method used in this program is the least squares procedure, whereby the nonlinear problem is linearized by expanding in a Taylor series. In the iterative method, one develops a starting nominal guess for the model parameters. A correction matrix is derived and then applied to the nominal guess to produce an improved set of model parameters. This procedure is continued until some predetermined criterion is satisfied. The number of iterations necessary for convergence is closely related to this criterion, the initial estimates, and the form of the exponential model.

Notes:

1. This program is written in FORTRAN V to be used on the UNIVAC-1108 computer and SC-4020 plotter.
2. Inquiries concerning this program should be directed to:

   COSMIC
   112 Barrow Hall
   University of Georgia
   Athens, Georgia 30601
   Reference: MFS-21965

Source: Bobby G. Junkin
Marshall Space Flight Center
(MFS-21965)

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