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NASA TECH BRIEF

Algebraic Monte Carlo Procedure Reduces Statistical Analysis Time and Cost Factors

The problem:

In statistically analyzing performance parameters in large, complex systems, various approaches have been explored in an effort to control the error factor. Two of these, the Monte Carlo method, and the root-sum-square method have been freely employed but exhibit certain deficiencies. Given an accurate simulation program and unlimited computer time, an output histogram can be constructed by the Monte Carlo method to any required accuracy. Because accuracy of the Monte Carlo procedure is proportional to the reciprocal of the square root of the sample size, those cases where the simulation program is expensive to operate would find a Monte Carlo study prohibitively costly.

In root-sum-square studies, individual one sigma perturbations on the input variables are run through the simulation program one at a time. The resultant effects on the output variable are root-sum-squared to get its standard deviation. Although a fast method, the assumptions required for use of the root-sum-square method are rarely satisfied by the factual situation.

The solution:

An algebraic Monte Carlo procedure that requires fewer restrictive assumptions than the root-sum-square method and that is significantly cheaper to operate than true Monte Carlo. Basically, the algebraic Monte Carlo procedure makes a series of perturbations on the input variables at selected probability levels. The effect on the output variables is fit with a series of polynomial curve fits. With the curve fits established the simulation program is no longer used, but instead, Monte Carlo samples are derived from the polynomials. This procedure drastically reduces the number of expensive simulations and, therefore, the analysis time. Additionally, the individual effects of input variables can be isolated and individual input statistics can be changed without having to repeat the entire analysis.

Notes:

1. By using the expectation operator, the input variables can be ranked in order of decreasing effect, allowing engineering effort to be focused on that reduction of statistics that will yield the greatest effectiveness.
2. Inquiries concerning this innovation may be directed to:

   Technology Utilization Officer
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   Reference: B67-10434

Patent status:

No patent action is contemplated by NASA.

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