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A BAYESIAN BATCH MEANS METHODOLOGY FOR ANALYSIS OF SIMULATION OUTPUT

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RESEARCH SUMMARY

1. THE PROCESS ASSUMPTIONS

The purpose of this research is to investigate the use of Bayesian methodology in the analysis of simulation output. Specifically, the Bayesian methodology is introduced in the context of the batch means procedure for building a confidence interval for the output mean. We assume that the output process is at steady state or equivalently that the output process is second order stationary. We also assume that the length is fixed at say n. So the output process can be given by

$$X_1, X_2, \ldots, X_n,$$

a sequence of observations from a continuous state stationary stochastic process with mean M, variance σ_x^2 and autocorrelation function $\{\rho_i\}_{i=1}^{\infty}$

In this research we batch the n observations into k batches of size m and assume that mk=n. The resulting batch means are assumed to be independent and normally distributed. This provides the setting for the Bayesian analysis.

2. THE BAYESIAN APPROACH

There are two major reasons why the Bayesian approach may be superior to the sampling theory approach. The Bayesian method incorporates more information by using prior information to supplement the collected data. And a Bayesian conclusion does not need a frequency interpretation.

The minimum components that comprise a Bayesian problem are (i) the form of the prior distribution, (ii) the assessment of the prior distribution, (iii) the form of the conditional distribution of the data, and (iv) the data. The data and the conditional distribution of the data are the same for the Bayesian and sampling theory approaches.

The form of the prior distribution and the assessment of the prior distribution are needed only in the Bayesian approach.

The specific Bayesian approach that we use in this paper is termed the normal-normal model, because the prior and the conditional distribution are both assumed to be normally distributed.

3. ASSESSMENT OF PRIOR PARAMETERS

The parameters of the prior distribution are assessed in two different ways. First, they are set based on the subjective judgment of the user.

In the absence of knowledge of the process we present a data determined prior which uses the variation between subgroups of the data to set the prior parameters.

4. RESULTS

This Bayesian batch means methodology has been thoroughly tested. The five measures of effectiveness suggested in Schriber and Andrews (1981) are reported for a variety of simulated theoretical output processes. In addition, each run is compared with various batch means procedures. In general, the incorporation of a prior distribution improves the interval estimate. The improvement is greatest when the prior information is accurate and the run length is small. Complete details may be found in Andrews and Schriber (1983).

REFERENCES

Andrews, R W, Schriber, T J (1983), A Bayesian Batch Means Methodology, Graduate School of Business Working Paper, The University of Michigan.

Schriber, T J, Andrews, R W (1981), A Conceptual Framework for Research in the Analysis of Simulation Output, Communications of the ACM, 24:218-234.