Computational Applications in Stochastic Operations Research

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Abstract

Several computational applications in stochastic operations research are presented, where, for each application, a computational engine is used to achieve results that are otherwise overly tedious by hand calculations, or in some cases mathematically intractable. Algorithms and code are developed and implemented with specific emphasis placed on achieving exact results and substantiated via Monte Carlo simulation. The code for each application is provided in the software language utilized and algorithms are available for coding in another environment. The topics include univariate and bivariate nonparametric random variate generation using a piecewise-linear cumulative distribution, deriving exact statistical process control chart constants for non-normal sampling, testing probability distribution conformance to Benford's law, and transient analysis of *M/M/s* queueing systems. The nonparametric random variate generation chapters provide the modeler with a method of generating univariate and bivariate samples when only observed data is available. The method is completely nonparametric and is capable of mimicking multimodal joint distributions. The algorithm is ``black-box," where no decisions are required from the modeler in generating variates for simulation. The statistical process control chart constant chapter develops constants for select non-normal distributions, and provides tabulated results for researchers who have identified a given process as non-normal. The constants derived are bias correction factors for the sample range and sample standard deviation. The Benford conformance testing chapter offers the Kolmogorov–Smirnov test as an alternative to the standard chi-square goodness-of-fit test when testing whether leading digits of a data set are distributed according to Benford's law. The alternative test has the advantage of being an exact test for all sample sizes, removing the usual sample size restriction involved with the chi-square goodness-of-fit test. The transient queueing analysis chapter develops and automates the construction of the sojourn time distribution for the nth customer in an *M/M/s* queue with k customers initially present at time 0 ($k \geq 0$) without the usual limit on traffic intensity, $\rho < 1$, providing an avenue to conduct transient analysis on various measures of performance for a given initial number of customers in the system. It also develops and automates the construction of the sojourn time joint probability distribution function for pairs of customers, allowing the calculation of the exact covariance between customer sojourn times.