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Phase-II Distribution-free Joint Monitoring of Location, Scale and Skewness

Monitoring time between events, operational delays or responding to a customer call is essential for maintaining and thriving to enhance service quality. Several aspects of the processes, including location such as median time, variability and shape, are pivotal. This paper introduces a Phase-II distribution-free cumulative sum (CUSUM) procedure based on a combination of three orthogonal rank statistics for simultaneously monitoring location, scale, and skewness aspects. The idea of multi-aspect process monitoring involving three orthogonal aspects using a single combined statistic is new, and previous works on Phase-II monitoring used three non-orthogonal statistics. The orthogonal statistics have certain advantages in performance and interpretation. A quadratic combination of three component statistics based on the Legendre polynomial is proposed for monitoring the shift in location, scale, and skewness. Earlier Legendre polynomial-based rank statistics were used in Phase-I applications but never studied in the context of Phase-II applications. Implementation design and post-signal follow-up procedure for identifying which parameter is more responsible for the signal are discussed. The In-control robustness of the proposed scheme is studied via simulation. The run-length properties of the proposed scheme are compared with various CUSUM schemes. The proposed scheme displays outstanding out-of-control performance in identifying a broad class of shifts involving one or more of the three parameters in an underlying process distribution. An illustration of the proposed scheme for monitoring the time it takes to deliver food items by an e-commerce facility is presented to explain manufacturing quality monitoring applications. We finally offer some concluding remarks.

Special/ Invited session

Classification

Both methodology and application

Keywords

Boos Statistic, Delivery Time, Multi-aspect Monitoring, Process Control, Rank Scores

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