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A Distribution-Free Shewhart Quality Control Chart Based on Signed-Ranks

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Abstract

Since their inception by Walter Shewhart in the late 1920s, most control chart developments have been distribution-based procedures in the sense that the process output is assumed to follow a specified probability distribution (normal for continuous measurements and binomial or Poisson for attribute data). Due to Deming's influence and their widespread adoption as one of the seven basic tools of total quality management (TQM), control charts have been applied to processes where data may be markedly nonnormal. In this article, we propose a distribution-free (or nonparametric) statistical quality control chart for monitoring a process center. The proposed chart is of the Shewhart type and is based on the signed-ranks of grouped observations. The exact false alarm rate and the in-control average run length of the proposed chart are computed by using the null distribution of the well-known Wilcoxon signed-rank statistic. The out-of-control run lengths are computed exactly for normal underlying distributions and by simulation for uniform, double exponential, and Cauchy shift alternatives. Efficiency studies show that the proposed chart is more

efficient than the traditional Shewhart X-bar chart under heavy-tailed distributions (the double exponential and the Cauchy) but is less efficient under light-tailed distributions (the uniform and the normal).

Keywords: [Average run length](#) [Control sequence](#) [False alarm rate](#) [Nonparametric](#) [Outliers](#) [Robustness](#) [Wilcoxon signed-rank statistic](#)



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