Contribution ID: **37**   Type: **not specified**

Anomaly Detection in Ordinal Quality-Related Processes by Control Charts

Wednesday, 15 May 2024 13:20 (20 minutes)

Control charts are a well-known approach for quality improvement and anomaly detection. They are applied to quality-related processes (e.g., metrics of product quality from a monitored manufacturing process) and allow to detect "deviations from normality", i.e., if the process turns from its specified in-control state into an out-of-control state. In this study, we focus on ordinal data generating processes, where the monitored quality metrics are measured on an ordered qualitative scale. A survey of control charts for the sample-based monitoring of independent and identically distributed ordinal data is provided together with critical comparisons of the control statistics, for memory-less Shewhart-type and for memory-utilizing exponentially weighted moving average (EWMA) and cumulative-sum types of control charts. New results and proposals are also provided for process monitoring. Using some real-world quality scenarios from the literature, a simulation study for performance comparisons is conducted, covering sixteen different types of control chart. It is shown that demerit-type charts used in combination with EWMA smoothing generally perform better than the other charts, although the latter may rely on quite sophisticated derivations. A real-world data example for monitoring flashes in electric toothbrush manufacturing is discussed to illustrate the application and interpretation of the control charts in the study.

Reference:

Ottenstreuer, S., Weiß, C.H., Testik, M.C. (2023)
A Review and Comparison of Control Charts for Ordinal Samples.
Journal of Quality Technology 55(4), 422-441.
Open Access: https://doi.org/10.1080/00224065.2023.2170839

Type of presentation

Contributed Talk

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Session Classification: Contributed session

Track Classification: Spring Meeting