

The modified p -Greenwood statistic and its application to distinguishing Gaussian and near-Gaussian distributions - platykurtic and leptokurtic cases

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Abstract

This paper introduces the modified p -Greenwood statistic, a novel generalization of the classical Greenwood statistic designed for goodness-of-fit testing. While traditional methodologies predominantly focus on exponentiality or specific heavy-tailed distributions, we extend this framework to a comprehensive range of distribution families, encompassing both leptokurtic and platykurtic classes. A primary theoretical contribution of this work is the characterization of the stochastic ordering of the statistic within analyzed classes, which provides the foundation for a formal Gaussianity testing framework. Furthermore, we develop a computational procedure for identifying the optimal parameter p , ensuring maximum statistical power when discriminating between Gaussian distributions and near-Gaussian alternatives within the analyzed classes. The proposed methodology is validated via extensive Monte Carlo simulations, demonstrating superior performance compared to established high-efficiency benchmarks, particularly in small-sample regimes. The practical utility of the approach is demonstrated through an application in condition monitoring area.

Keywords

Greenwood statistic, modified Greenwood statistic, platykurtic distribution, stochastic monotonicity, star-shaped order, statistical testing, Monte Carlo simulations, machine diagnostic signal

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