

Fractional lower-order covariance-based measures for cyclostationary time series with heavy-tailed distributions: application to dependence testing and model order identification

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Abstract

This presentation introduces new methods for the analysis of cyclostationary time series with infinite variance. Traditional cyclostationary analysis, based on periodically correlated (PC) processes, relies on the autocovariance function (ACVF). However, the ACVF is not suitable for data exhibiting a heavy-tailed distribution, particularly with infinite variance. Thus, we propose a novel framework for the analysis of cyclostationary time series with heavy-tailed distribution, utilizing the fractional lower-order covariance (FLOC) as an alternative to covariance. This leads to the introduction of two new autodependence measures: the periodic fractional lower-order autocorrelation function (peFLOACF) and the periodic fractional lower-order partial autocorrelation function (peFLOPACF). These measures generalize the classical periodic autocorrelation function (peACF) and periodic partial autocorrelation function (pePACF), offering robust tools for analyzing infinite-variance processes. Two practical applications of the proposed measures are explored: a portmanteau test for testing dependence in cyclostationary series and a method for order identification in periodic autoregressive (PAR) and periodic moving average (PMA) models with infinite variance. Both applications demonstrate the potential of new tools, with simulations validating their efficiency. The methodology is further illustrated through the analysis of real-world air pollution data, which showcases its practical utility. The results indicate that the proposed measures based on FLOC provide reliable and efficient techniques for analyzing cyclostationary processes with heavy-tailed distributions.

Keywords

Cyclostationary time series, Heavy-tailed distribution, Fractional lower-order covariance, Testing dependence, PARMA model, Order identification

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