Spectral Density Estimation in Time Series Analysis for Dynamical Systems

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Abstract: The study proposed in this paper introduces an innovative approach for estimating spectral density in time series analysis within the framework of dynamical systems, which is considered to be the most powerful tool in the statistical treatment of stochastic processes. Spectral density estimation is a crucial tool for understanding the frequency domain characteristics of time series data, particularly in complex dynamical systems. Our analytical results are validated by numerical simulation of the stochastic model. The Yule-Walker technique is used to show the attainment level of the model parameter estimation and the comparison is also made for this estimation. Our approach improves accuracy in capturing spectral characteristics, addressing the challenges posed by nonlinearities inherent in the data. Through empirical and theoretical validation, we demonstrate its efficacy in unraveling time series complexities.

Keywords: *asymptotic properties; ARMA models; Fourier analysis; dynamical periodogram; spectral density.*

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