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ENHANCING ROBUSTNESS IN 1D FOURIER TRANSFORMATION: AN INVERSION-BASED APPROACH USING GEGENBAUER POLYNOMIALS

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This study presents a novel methodology for 1D Fourier transformation that leverages Gegenbauer polynomials to enhance robust signal analysis. By employing an inversion-based approach, we address the challenges posed by noisy datasets and outliers. The proposed method utilizes the Iteratively Reweighted Least-Squares Fourier Transform (J-IRLS-FT), which integrates Steiner's Most Frequent Value technique to improve the accuracy of Fourier spectrum estimation. Through the application of Gegenbauer polynomials, our approach effectively constructs an overdetermined inverse problem, allowing for precise approximation of the Fourier spectrum via series expansion. The flexibility of Gegenbauer polynomials, with specific parameter configurations, contributes to the adaptability of the method, enabling seamless transitions into other polynomial families. Comparative analyzes demonstrate that our inversion-based Fourier transformation significantly reduces noise sensitivity compared to conventional Discrete Fourier Transform (DFT).
This innovative technique proves particularly effective for accurately characterizing noiseless datasets while maintaining robustness in the presence of noise and outliers.