New Applications of Spectral Decomposition in Forecasting and Hypothesis Testing

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Abstract

This study explores novel applications of spectral decomposition in the realms of forecasting and hypothesis testing. While spectral decomposition has been extensively studied across various disciplines, its potential in these specific areas remains largely untapped. The research presents two key applications: (1) time series forecasting, exemplified through cryptocurrency price prediction, and (2) hypothesis testing, demonstrated with a novel approach in fixed-effects panel models.

In time series forecasting, the study employs time-delay embedding and spectral decomposition to transform cryptocurrency price data. This transformation process involves several steps, including the separation of the training and test sets, identification of governing patterns (the eigenvectors related to the smallest eigenvalues) of each input sequence in the training set, and the transformation of the test set based on these vectors. The transformed test set is then classified using traditional machine learning algorithms with 10-fold cross-validation.

In the context of hypothesis testing, the study introduces a random matrix theory-based testing procedure for identifying both linear and non-linear cross-sectional dependencies in the residual matrix of panel models. By applying the Tracy-Widom law, this method leverages the largest eigenvalue of the symmetrized residual matrix as a test statistic, providing a more robust alternative to traditional tests that rely on strong assumptions about the error structure.

Results indicate that our applications of spectral decomposition notably improve forecasting accuracy and offer superior robustness in hypothesis testing compared to traditional methods. While acknowledging limitations, the study suggests avenues for future research to enhance the applicability of the proposed methodologies.

Keywords: Spectral Decomposition, Forecasting, Hypothesis Testing, Representation Learning