Enhanced Cycle Scanner: White Paper

Abstract

This white paper presents an enhanced cycle detection and forecasting methodology for financial time series, building on and extending the work of Lars von Thienen. The approach combines advanced time series decomposition (trend, seasonality, and drift), robust cycle validation, and interactive reporting. Key innovations include dynamic harmonic regression, robust statistical validation, multi-timeframe analysis, and a summary heatmap for sustainability and predictability of cycles. A further enhancement is the focus on the most recent market regime: for each timeframe, the analysis is performed on the latest segment starting from the most recent major high or low, with several segment lengths (300, 500, 1000) considered. This enables more relevant, actionable, and efficient cycle analysis. An 'uber-report' ranks and links all variants.

Introduction

Cycle analysis is a cornerstone of quantitative finance and economic research. This paper introduces a modern, robust, and open-source implementation of cycle detection and forecasting, tailored for non-stationary financial time series such as Bitcoin.

Background

Lars von Thienen's original cycle scanner algorithm provided a foundation for cycle detection in financial data. However, evolving market dynamics, non-stationarity, and the need for reproducibility demand more advanced, transparent, and extensible tools.

Mathematical Formulation

The methodology decomposes the observed price series y_t as:

$$y_t = T_t + S_t + C_t + e_t$$

where T_t is the trend, S_t is the (possibly drifting) seasonal component, C_t is the cycle, and e_t is noise.

Dynamic Harmonic Regression and State Space Models are used for decomposition. Cycle

detection is performed on the residuals using FFT, and statistical significance is validated using the Bartels test.

Enhanced Methodology

For each timeframe, the latest segment is extracted from the most recent major high or low (using prominence-based peak/trough detection), with segment lengths of 300, 500, and 1000. Each variant is analyzed independently. This approach focuses on the most relevant market regime and enables robust, comparative cycle analysis.

Implementation Details

The implementation is in Python and leverages pandas, numpy, statsmodels, scipy, and plotly. The pipeline is automated, supports multiprocessing, and generates interactive HTML reports for each timeframe and variant. Each variant is saved in its own directory. An 'uber-report' ranks all variants and links to their summary reports.

Results & Interpretation

The scanner produces interactive reports for each timeframe and variant, showing decomposition, cycle detection, and forward projections. The summary heatmap and ranking table allow for quick identification of the most sustainable and predictable cycles. The uber-report enables comprehensive comparison and selection of the best variant for further analysis or trading strategy development.

References

- Lars von Thienen, Cycle Scanner Algorithm, Foundation for the Study of Cycles

- Hyndman, R.J., & Athanasopoulos, G. (2018). Forecasting: principles and practice.

- Box, G.E.P., Jenkins, G.M., Reinsel, G.C., & Ljung, G.M. (2015). Time Series Analysis: Forecasting and Control.

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Code Availability

The Enhanced Cycle Scanner code, which implements the methods described in this paper, has been released as open-source software. It is licensed under the GNU General Public License v3.0 (GPLv3) and is copyright Eduard Samokhvalov (2025), with a specific grant for use by the Foundation for the Study of Cycles. The full license text is available in the LICENSE file included with the code. The code repository can be accessed at: https://github.com/algomaschine. For questions or collaboration, contact the author at: edward.samokhvalov@gmail.com. Open-sourcing this implementation facilitates further research, reproducibility, and application by the community.