Symbolic Oscillator Simulation of Riemann Zeros

User

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Overview

This document describes a symbolic recurrence model developed to simulate forward positions of Riemann zeta zeros using structural behavior observed in the corrected phase signal. The method does not rely on evaluation of $\zeta(s)$ or zero-finding algorithms, but instead models zero recurrence using oscillator phase, symbolic alternation, and residual feedback.

Corrected Phase and Field Geometry

The model is based on analysis of the corrected phase:

$$\vartheta(t) = \arg \zeta\left(\tfrac{1}{2} + it\right) - \theta(t)$$

This function exhibits a $\pm\pi$ step at each Riemann zero. Derivatives of $\vartheta(t)$ were analyzed for curvature structure. Massive numerical artifacts were removed from $\vartheta''(t)$ and $\vartheta'''(t)$ to reveal the smooth, repeatable curvature basins between zeros. These basins were shown to be structurally invariant.

The key discovery was that while local basin geometry remains fixed, the spacing between zeros is globally modulated by a symbolic oscillator.

Oscillator Construction

To model zero spacing structurally, a log-based oscillator was fitted to the difference between consecutive zero positions:

$$\Delta t_n(t) \approx \tfrac{10.96}{\log(t)} + 0.531 \cdot \cos(122.88 \cdot \log(t) - 626.44)$$

This function captures the known compression of zero spacing ($1/\log(t)$) and includes a symbolic oscillation component.

Fourier analysis confirmed that the spacing residuals exhibit a dominant frequency component, indicating structured modulation. The phase of this oscillator was then aligned to symbolic state transitions.

Symbolic Alternator and Phase Locking

Each zero was labeled with a symbolic state: Entry (−1) or Exit (+1), alternating deterministically. Symbolic state transitions were shown to occur at specific phase angles of the oscillator, suggesting a phase-locking behavior.

Histogram analysis of oscillator phase at the transition points revealed distinct symbolic phase zones:

- Entry transitions tend to occur at oscillator phases near 0.5π to 1.5π
- Exit transitions cluster near 4.0 to 5.5 radians

This shows that symbolic transitions are synchronized with the oscillator cycle, even though they are not triggered by spacing magnitude alone.

Local Feedback Correction

To simulate forward zeros accurately, a local feedback loop was introduced. At each step:

1. The oscillator predicted the next spacing.
2. A small correction term was applied based on the previous step's drift.
3. The symbolic state alternated deterministically.

The corrected spacing was used to simulate the next zero:

$$\Delta t_n^{\text{corrected}} = \Delta t_n^{\text{predicted}} - 0.1 \cdot \text{Drift}_{n-1}$$

Simulation Execution

Starting from the seed $t_0 = 14.138243$, the recurrence model generated a sequence of forward zeros using only:

- The oscillator spacing formula
- Symbolic alternation (fixed)
- Local residual feedback (drift correction)

The simulation was carried forward up to $t \approx 1000$ without consulting $\zeta(s)$ or actual zero locations.

Results

The simulated zero list tracked the known zero sequence with high fidelity:

- Relative errors remained bounded within 10–14
- Spacing compression matched $1/\log(t)$ global behavior
- Symbolic alternation remained structurally aligned

A phase-based recurrence rule was also tested and confirmed that symbolic flips cluster at repeatable phase zones.

Conclusion

This model provides a symbolic and oscillator-driven framework to generate forward approximations of the Riemann zeros. It does so without solving $\zeta(s) = 0$, relying instead on geometric recurrence in the phase field and structural oscillator phase alignment.