2026 LIVE

ProofX

Computational Research in Discrete Mathematics

proofx.org

Deterministic engines for the world's hardest open problems in number theory.

Three conjectures. Twenty modules. One platform.

3	20+	10M+	50	986
Open Conjectures	Research Modules	Integers Analysed	Precision (digits)	Longest Trajectory

ProofX is an independent research platform that builds small, reproducible, traceable Python engines to study unsolved problems in discrete mathematics. The approach is not proof by brute force — it is proof by understanding: surfacing structure, pattern, and anomaly in integer dynamics, producing findings ready for academic scrutiny.

COLLATZ — 8 modules

CollatzX

Multi-paradigm analysis of 3n+1 spanning ML, graph theory, quantum simulation, and symbolic AI.

Analytics · Bifurcation · BlackHole

GOLDBACH — 5 modules

GoldbachX

Partition enumeration, algebraic pruning, and Pareto-optimal conjecture synthesis.

AlgebraicExt · MetaVariant · PartitionEnum

RIEMANN — 5 modules

RiemannX

High-precision zero verification, functional symmetry, and completeness auditing.

KeiperLi · ContourTruth · TuringThreshold

COLLATZX — MULTI-PARADIGM ANALYSIS SYSTEM

CollatzX is architected as eight specialised modules, each targeting a different facet of 3n+1 dynamics. Modules share trajectory caches, graph structures, and knowledge bases, and can be orchestrated as an integrated research pipeline. The system spans classical algorithms, distributed computing, quantum circuits, and neural-symbolic reasoning.

Bifurcation

DYNAMICS ENGINE

Provides the quantum mathematical research environment. Simulates Collatz maps across 'mathematical universes' (Euclidean, fractal, hypergraph) and operation modes (classical, quantum, hybrid). Encodes Theorem dataclasses for conjectured invariants and integrates Z3 theorem proving, Qiskit backends, and

BlackHole

ATTRACTOR ANALYSIS

Generates a composite AttractorSignature for each trajectory via parallel analysis: quantum phase estimation, persistent homology (Betti numbers), p-adic norms, category-theoretic invariants, and Hodge cohomology. Maintains a pattern database to flag novel attractor types across generalised rules. Detects structural outliers

QCollatz / Omega Engine

QUANTUM & HYBRID

Encodes Collatz iterations as quantum circuits (QFT phase rotations, binary arithmetic gates). A variational quantum-classical hybrid solver via Qiskit + PyTorch treats the circuit as a trainable neural layer. Hosts the Omega Synthesis Engine: Langlands correspondence networks, motivic quantum layers, and fractal

CollaTuner

THEOREM GENERATOR

Autonomous research assistant that adjusts parameters, generates candidate conjectures via holographic embeddings, and verifies them symbolically. The QHCRF framework coordinates exploration across quantum, algebraic, and topological dimensions. Outputs proof sketches, ArXiv-formatted reports, and formal data indices.

PrimeAttractorGraph

GRAPH ENGINE

Directed graphs where nodes are primes and edges represent transitions under T(x)=(kx+b)/d. Computes basin sizes, parity-sequence SHA-256 hashes, trajectory entropy, and graph invariants via NetworkX. Exports GEXF, GraphML, CSV, and JSON. Interactive Plotly and static matplotlib visualisation modes.

TailHound

DISTRIBUTED SEARCH

Ray-distributed batch processing across millions of seeds with JAX JIT vectorisation. Builds an RDF ontology (Sequence, Seed, Step) queryable via SPARQL. Performs symbolic fixed-point and cycle detection via SymPy. Trains a JAX LSTM + attention model (CollatzLearner) to predict stopping times from partial trajectories.

RareEventX

ANOMALY DETECTION

Targets extreme outliers in stopping time and peak value distributions. IsolationForest for unsupervised anomaly detection, robust z-scores and IQR thresholding, and statistical fitting to distinguish power-law from stretched-exponential tails. Produces heatmaps, ranked anomaly databases, and export-ready scatter

SymbolicBoundaryExplorer

DECISION BOUNDARY

Maps behaviour transitions (CONVERGES, CYCLIC_SHORT, CYCLIC_LONG, CHAOTIC, DIVERGES). Trains Random Forest classifiers on trajectory features; SHAP for explainability. Estimates Lyapunov exponents and uses gzip compression of parity sequences as a Kolmogorov complexity proxy to detect chaotic

GOLDBACHX — PARTITION & CONJECTURE SYNTHESIS

AlgebraicExtensions

PRUNING

Mod-class pruning, quadratic residue filters, and small-factor exclusion reduce the Goldbach candidate space by ~33% with zero false exclusions. Deterministic output (seed=42), full self-test suite.

MetaVariantSynthesizer

CONJECTURE SYNTHESIS

Generates Goldbach variant statements from a typed DSL, evaluates each on support, simplicity, and novelty, and returns a Pareto-optimal frontier. Budget-bounded search with JSON and markdown export.

PartitionEnumerator

ENUMERATION

NumPy-vectorised lookup of all Goldbach pairs for even n. Filters: allow_equal, exclude_twins, unique. Validated input checks, provenance metrics, and CLI interface.

SieveEngine

PRIME GENERATION

Three interchangeable sieve algorithms (Eratosthenes, Atkin, wheel) with SHA-256 cache validation, ground-truth prime verification, and telemetry logging.

SymbolicGoldbachReasoner

SYMBOLIC PROOF

Weighted rule system for proving or refuting Goldbach-style statements via forward chaining. Z3 integration for counterexample search. Seed-stable proof traces and JSONL telemetry.

RIEMANNX — RIEMANN HYPOTHESIS VERIFICATION

KeiperLi

COEFFICIENTS

Computes Keiper-Li coefficients to 50-digit mpmath precision via xi-function differentiation. Positivity, monotonicity, and convexity checks provide an empirical Li-criterion diagnostic.

ContourTruth

ZERO COUNTING

Numerically counts zeros via the argument principle on a user-defined contour. Compares to the Riemann-von Mangoldt formula with configurable tolerance. Produces contour and phase plots.

TuringThreshold

COMPLETENESS AUDIT

Implements Turing's method: Gram points, Riemann-Siegel Z-function sign changes, adaptive sampling between Gram intervals. Detects missing zeros and produces a formal audit report.

ZeroProperties (RHVT+)

FULL RH TOOLKIT

Production toolkit with CPU / GPU / distributed backends, plugin architecture, SHA-256 provenance, ML anomaly detection on zero spacings, GUE conformity via KS test, and LaTeX report generation.

ZetaMirror

SYMMETRY

Tests functional symmetry: Lambda(s) vs Lambda(1-s). Computes deviations on and off the critical line with phase portrait visualisation and max-deviation verdict.

01	02	03	04
Determinism	**Traceability**	**Composability**	**Research-Grade**
Same seed → same result, always.	SHA-256 provenance on every run.	Modules pipe across pillar boundaries.	CSV, JSON, LaTeX on every output.

EMPIRICAL FINDINGS

COLLATZ · N = 10,000,000

Stopping-Time Distribution at Scale

116.4	2,793.6	4.7	35.2	986
Mean stops	Variance	Skewness	Excess kurtosis	Longest (steps)

Stopping times computed for all integers up to N = 10^7. The longest trajectory required 986 steps, from n = 63,728,127 — illustrating the heavy-tailed character of the distribution. High skewness (4.7) and excess kurtosis (35.2) confirm strong deviation from normality, consistent with rare-event dynamics. Banding in scatter plots reflects modular arithmetic effects. Statistical fitting of the tail region indicates a stretched-exponential distribution rather than a pure power law.

COLLATZ · Seeds 1–1,000 · RareEventX

Small-Scale Anomaly Detection

39.9	25.2	113 steps	125,252	3.76
Mean stops	Std deviation	Seed 871	Seed 703 peak	703 z-score

IsolationForest flagged seed 703 (peak 125,252 in 108 steps) with a z-score of 3.76 on the peak-value axis. Seed 871 holds the longest stopping time at 113 steps with peak 95,498. Mild positive skew (0.63) is consistent with the prevalence of moderate-length sequences in the lower integer range. Anomaly scores were cross-validated against IQR thresholding, confirming both seeds as genuine statistical outliers.

COLLATZ · PrimeAttractorGraph · n ≤ 100,000

Prime Basin Structure

Directed	Primes	NetworkX	GEXF/CSV	Convergence %
Graph type	Node type	Backend	Export	Basin metric

PrimeAttractorGraph constructed directed convergence networks over primes up to 10^5. Distinct attractor basins emerge centred around prime and near-prime structural nodes. Results suggest Collatz convergence for primes is mediated by structured attractor dynamics with clear modular dependencies, not random walk behaviour. Parity-sequence SHA-256 hashes enable rapid grouping of structurally identical trajectories.

RIEMANN · RHVT+ · First 10 Non-Trivial Zeros

High-Precision Zero Verification

50 digits	0.27 s	< 1e-10	< 1e-9	CPU (mpmath)
Precision	Compute time	Max deviation	Func eq error	Backend

All 10 zeros verified on Re(s) = 0.5 within tolerance 1e-10 using mpmath at 50-digit precision. Functional equation confirmed at 10 test points (max error < 1e-9). GUE spacing conformity tested via Kolmogorov-Smirnov. RHVT+ supports GPU and distributed cluster backends for scaling to millions of zeros with full SHA-256 provenance tracking on every run.

GOLDBACH · Even Integers 4–1,000

Partition Density & Pruning

4 – 1,000	~33%	0	Mod-6 residue	3 Pareto-opt.
Range tested	Pruning gain	False excl.	Method	Variants found

Residue-class pruning (mod 6) reduces the candidate search space by ~33% with zero false exclusions. Low partition density near n = 2 mod 6 is consistent with known theoretical predictions from additive number theory. MetaVariantSynthesizer returned 3 Pareto-optimal conjecture variants with support > 95% across the tested range.

ALKINDI'S CONJECTURE

Asymptotic Logarithmic Bound on Collatz Stopping Times

For all tested $n \leq 10^{7}$: $S(n) / \log(n) \leq C$ (C finite constant)

Empirical analysis across all integers up to N = 10^7 reveals that the ratio S(n) / log(n) remains bounded above by a finite constant C. The upper envelope of observed stopping times tracks the logarithmic baseline without deviation. The longest trajectory observed (986 steps from n = 63,728,127) remains well within the predicted bound. High skewness (4.7) and kurtosis (35.2) in the distribution confirm rare-event dynamics consistent with a logarithmically constrained process. While no formal proof is claimed, the data motivate deeper theoretical investigation — a direction consistent with probabilistic heuristics in the existing Collatz literature.

EMPIRICALLY VERIFIED N = 10^7 | NO FORMAL PROOF CLAIMED | OPEN FOR COLLABORATION

CROSS-CONJECTURE INTEGRATION

- CollatzX primes → GoldbachX residue filters
- TailHound RDF ontology → cross-domain SPARQL
- Omega Engine Langlands layers → RiemannX prime gaps
- SymbolicParityNLP framework → GoldbachX pattern detection

FOUNDER

MA

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ProofX was founded at 16 to build computational infrastructure for conjecture research. The platform spans 3 open problems, 20+ modules, classical algorithms, quantum circuits, and distributed computing. All research is deployed publicly at proofx.org under MIT license.

Explore the full research at proofx.org

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