

Davian R. Chin

Scientific Machine Learning Researcher — Fractional Calculus & Neural Dynamics

davianc@proton.me | d.r.chin@pgr.reading.ac.uk | +44 7549 039554 | Reading, UK
linkedin.com/in/davianc | github.com/dave2k77 | ORCID 0009-0003-9434-3919

Research Profile

Scientific machine learning researcher and computational scientist (PhD candidate; Fellow of the IMA) working on the mathematical and computational foundations of inference for complex dynamical systems. My doctoral research investigates structural limitations of classical long-range dependence (LRD) inference for heavy-tailed and non-stationary processes. I am developing a scale-organised, null-relative dependence framework combining multiscale regularity, moment-free dependence measures and aggregation-limit behaviour, assessed relative to matched short-memory reference models. I build reproducible benchmark suites and GPU-accelerated generative models in Python, JAX and PyTorch to stress-test statistical and scientific machine learning methods under controlled departures from their assumptions. Broader interests include fractional dynamics, differentiable simulation, operator learning and physics- and biology-informed modelling, particularly for neural time series.

Research Interests

- **Stochastic dependence and scale-free dynamics:** long-range dependence, heavy-tailed and non-stationary processes, multiscale, moment-free and null-relative inference.
- **Function-space and operator methods:** Besov and Sobolev regularity, wavelets, functional analysis and operator theory for stochastic systems.
- **Fractional dynamics:** fractional calculus, fractional ODEs and SDEs, memory effects and non-local dynamics.
- **Scientific machine learning:** neural operators, physics-informed learning, differentiable simulation and scientific generative modelling.
- **Neural and complex systems:** criticality, self-organisation and scale-free neural dynamics.
- **Trustworthy computational science:** uncertainty quantification, benchmarking, reproducibility and open research software.

Education

PhD, Biomedical Engineering (Computational Neuroscience & Neural Dynamics) University of Reading, UK – 2025–present (expected 2028)

Working Thesis: *Long-range dependence in heavy-tailed and non-stationary processes: theory, inference and neural applications* (supervisors: Prof. W. Holderbaum, Prof. S. Nasuto). Focus: fractional function spaces (Sobolev–Slobodeckij, Besov), stochastic fractional neural dynamics, physics-informed operator learning.

MSc, Computer Science (AI, ML & Big Data Technologies) University of East London, UK – 2023
Focus: physics-informed neural operators for heat/diffusion PDEs; machine vision; big-data analytics.

MA, Education (Development, Management & Technology) University of South Wales, UK – 2018
Dissertation: computational thinking as a framework for mathematics education.

BSc, Mathematics & Computer Science University of the West Indies, Jamaica – 2008
Pure and applied mathematics with mathematical modelling and operations research.

Research Experience

PhD Researcher — Fractional Calculus, Scientific Computing & Machine Learning University of Reading – 2025–present

- **Empirical benchmarking:** created and released `lrdbench`; evaluated 15 classical, machine-learning and neural LRD estimators across canonical, contaminated and observational regimes; quantified heavy-tail failure, uncertainty and cross-estimator disagreement.
- **Theory:** developing a scale-organised, null-relative theory of long-range dependence for non-stationary and heavy-tailed stochastic processes. Formalising the Variance Trap, showing how classical second-order estimators can confound dependence with tail behaviour, drift and finite-scale contamination; replacing single Hurst/covariance summaries with a multiaxial dependence field defined relative to nuisance-matched short-memory nulls.

- **Mathematical framework:** constructing moment-free and sub-quadratic dependence coordinates using Besov/Sobolev regularity, wavelet scaling, excursion geometry, lower-order moments, characteristic-function/codifference methods and aggregation-limit behaviour, with localisation for non-stationary processes.
- **Generative ground truth:** developing `hpfracc`, a JAX-native fractional-calculus and differentiable simulation framework for controlled stochastic ground truth, including Riemann–Liouville, Caputo and Grünwald–Letnikov operators, adaptive solvers and fractional neural dynamics.
- **Scientific application:** using controlled fractional and scale-free generative models to test whether dependence structure associated with neural criticality remains identifiable under heavy tails, non-stationarity and observational distortion.
- **Research software:** releasing reproducible scientific software with automated testing, CI, documentation and archival DOIs; disseminating work through invited talks, conference presentations and research posters.

Applied ML Research (MSc projects)

University of East London – 2021–2023

- Built a physics-informed Fourier neural operator solving the 1D/2D heat equation, studying physics-loss weighting versus Fourier-analysis techniques for data-efficient PDE surrogate modelling.
- Built, trained and deployed CNN/DNN machine-vision models and tree/ensemble/SVM classifiers on a big-data stack; benchmarked optimisation strategies for high-accuracy image classification.

Open-Source Research Software

- **lrdbench** Python – PyPI v1.2.1 – Zenodo 10.5281/zenodo.20937726 – docs at lrdbench.readthedocs.io
Reproducible benchmark framework for LRD estimators: ground-truth, stress-test and observational modes; bundled temporal, spectral, geometric, wavelet, aggregation and data-driven estimator families; contamination operators (heavy-tailed noise, level shifts, outliers, trends); uncertainty-aware interval-coverage reporting; manifest-driven, provenance-complete execution.
- **hpfracc** Python/JAX – Zenodo 10.5281/zenodo.20942679
Research-support library for fractional calculus and fractional dynamical systems in differentiable scientific computing: RL/Caputo/GL operator families, explicit/implicit, non-uniform and adaptive Caputo FDE solvers, experimental neural FODE workflows, probabilistic calibration and stochastic simulation helpers.
- **fracres** Python/JAX + Equinox
Fractional reservoir computing for critical (phantom) brain dynamics: reservoir nodes carrying fractional (power-law) memory, heavy-tailed fGn drive, Besov/ L^p regulariser via FFT Littlewood–Paley decomposition, quasi-self-organised-criticality homeostatic threshold.
- **fourier_pino_model** Python/PyTorch
Physics-informed Fourier neural-operator surrogate for the 1D/2D heat equation.

Publications, Manuscripts & Conference Contributions

- Batic, D., Chin, D. & Nowakowski, M. (2011). The repulsive nature of naked singularities from the point of view of Quantum Mechanics. *European Physical Journal C*, 71, 1624. doi:10.1140/epjc/s10052-011-1624-3
- *In preparation:* “A benchmark of classical LRD estimators on neural time series” (target: *NeuroImage* / IEEE TBME); “lrdbench: a reproducible benchmark framework for long-range dependence estimation” (target: JOSS); “The Variance Trap” (target: *J. Stat. Mech.*).
- Talk & poster: *Trustworthy methods for scientific discovery in critical brain research*, School of Biological Sciences ECR Symposium, University of Reading, July 2026.
- Poster: *Fat-tail phenomena and long-memory processes in biological systems*, School of Biological Sciences & Biomedical Engineering Research Conference, University of Reading, 2025.

Technical Skills

- **Scientific computing:** JAX, Equinox, NumPyro, PyTorch, NumPy/SciPy, scikit-learn, pandas, Matplotlib; GPU/CUDA, HPC, Colab/Cloud, experiment tracking.
- **Mathematics & modelling:** fractional calculus and FDEs, stochastic processes and SDEs, functional analysis/operator theory, wavelets, numerical methods, dynamical systems/criticality, Bayesian inference, time-series analysis.
- **Machine learning:** neural operators, PINNs, neural (F)ODEs/SDEs, reservoir computing, surrogate modelling, deep learning (CNN/RNN/LSTM), classical ML.

- **Software & MLOps:** Python (primary), R, MATLAB, C/C++, SQL, Haskell, L^AT_EX; Git/GitHub, CI, Docker, Linux; reproducible, provenance-complete workflows.
- **Domains:** computational neuroscience, biomedical engineering, EEG/neural time-series analysis, scientific software engineering.

Professional Memberships

Fellow, Institute of Mathematics and its Applications (FIMA).

References available on request.