

Charlie A. Johnson

AI Engineer & Computational Neuroscience Researcher

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PROFILE

AI engineer and researcher combining mathematical foundations (algebraic topology, persistent homology) with neuroscience research and six years of production systems engineering. Currently completing an MSc in Computer Science at the University of Birmingham, where I am conducting original research on geometric inference methods for neural dynamics under Dr Felipe Orihuela-Espina. I build AI systems informed by how biological intelligence processes information — from LLM applications and agentic architectures to topological analysis of high-dimensional brain imaging data. Seeking AI engineering roles where mathematical depth and systems thinking converge.

RESEARCH

Computational Neuroscience — Geometric Inference for Neural Dynamics 2025 – Present
University of Birmingham — Supervised by Dr Felipe Orihuela-Espina (Assoc. Prof.)

Developing a novel three-layer inference framework (Topology–Orientability–Chirality) for classifying latent manifold structure in high-dimensional neural time series, with application to fNIRS neuroimaging data from surgical neuroergonomics studies.

- Designed persistent homology pipeline distinguishing toroidal from non-orientable (Klein bottle) latent manifolds via coefficient-field sensitivity and tangent-transport frustration scoring
- Formalised geometric coupling — a structural dependence concept detecting constraints between neural signals invisible to correlation, mutual information, or spectral coherence
- Proved mirror antisymmetry theorem for chirality detection and derived finite-sample convergence bounds for orientability score stability
- Framework includes complete benchmark protocol with synthetic manifold generators, noise/sampling stress tests, and four-stage validation ladder (face, internal, content, concurrent validity)
- **Tools:** Python, Ripser, GUDHI, NumPy, SciPy. Paper in preparation for peer review.

SELECTED PROJECTS

cortex-rag — Document Q&A with Retrieval-Augmented Generation

- Built end-to-end RAG system with FastAPI backend, ChromaDB vector store, and Claude API integration for document question-answering with source attribution
- Implemented chunking strategies (fixed, semantic, recursive) with retrieval quality evaluation measuring faithfulness, answer relevance, and context precision

ticker — Multi-Agent LLM Simulation Platform

- Designed deterministic agent-economy where LLM agents generate, price, and trade structured reasoning artefacts under budget constraints with escrow-gated settlement
- Built orchestration layer in Python (asyncio, Pydantic, SQLite, DuckDB) with content-addressed storage, seeded replay, and full event logging for reproducibility
- Integrated OpenAI and Anthropic APIs for structured tool use, function calling, and cross-model evaluation scoring

ticker-realtime-ml — Financial ML Pipeline

- Developed real-time prediction serving pipeline with LSTM+Attention architecture, feature engineering, and REST API endpoint for inference

kv-cache-tradeoffs — LLM Internals Analysis

- Investigated KV cache compression and attention mechanism tradeoffs in production LLM serving, with quantitative analysis of memory-quality degradation regimes

PROFESSIONAL EXPERIENCE

Systems Modelling Lead — Scalable Infrastructure

2022 – 2025

Aurelle

- Owned core business systems across finance, supply chain, and fulfilment during 200%+ annual growth, maintaining 99.5% on-time delivery across 206,000+ orders
- Designed financial forecasting, cash-flow planning, and procurement automation pipelines with explicit invariant enforcement

- Built leading-indicator inference frameworks under incomplete information for high-volume operational decision-making

Systems Engineering Associate — Regulated Financial Systems

2019 – 2022

KPMG

- Translated complex regulatory requirements (FDIC 370) into system and data-architecture modifications across core banking environments at Tier-1 financial institutions
- Conducted dependency mapping and change-control planning under zero-loss safety constraints with complete traceability

Systems Engineering Intern — Internal Tools & Automation

2016 – 2019

Siemens

- Built structured automation tools, data models, and configuration systems for complex engineered product lines (low-voltage power distribution)
- Designed and shipped internal applications (iOS) replacing manual sales and quoting workflows

E D U C A T I O N

MSc Computer Science (AI/ML Focus)

2025 – 2026

University of Birmingham

Machine Learning, Software Architecture, Data Systems, Algorithmic Reasoning. MSc dissertation: geometric inference for neural dynamics (supervised by Dr Felipe Orihuela-Espina).

BSc Systems Engineering

University of Georgia

Dean's List. Foundation in systems thinking, formal modelling, and engineering design.

T E C H N I C A L S K I L L S

- **Languages & Core:** Python (NumPy, SciPy, Pandas, Pydantic, asyncio), SQL, Git/GitHub
- **AI & LLM Systems:** OpenAI API, Anthropic API, Hugging Face, RAG pipelines (ChromaDB, FAISS), structured generation, evaluation frameworks, prompt engineering
- **ML & Research:** PyTorch, persistent homology (Ripsler, GUDHI), topological data analysis, time-series analysis, experimental design, statistical inference
- **Infrastructure:** FastAPI, Flask, SQLite, DuckDB, Docker, CI/CD pipelines
- **Domain Knowledge:** Neuroimaging (fNIRS), algebraic topology, manifold inference, regulated financial systems, systems architecture at scale