Brian Hepler, PhD

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PROFESSIONAL SUMMARY

Data Scientist with a Ph.D. in Mathematics and over a decade of experience tackling complex analytical problems through advanced mathematical modeling and theoretical research. Recently focused on algorithm development and hands-on machine learning implementation, building on a strong cross-disciplinary foundation in quantum computing, mathematics research, and applied data science. Demonstrated ability to translate abstract concepts into impactful, production-ready computational tools, and skilled at communicating technical findings to non-technical stakeholders. Currently seeking data-driven roles within technology and research-oriented industries, leveraging deep technical expertise and proficiency in Python.

TECHNICAL SKILLS

- **Languages:** Python, SQL, LaTeX
- **ML Libraries:** Scikit-learn, PyTorch, XGBoost, NumPy, SciPy, Pandas, Matplotlib, NetworkX
- **Tools:** Jupyter, Git, ipywidgets, PostgreSQL
- **Specializations:** Machine Learning, Statistical Modeling, Quantum Computing, Algebraic Topology, Category Theory, Graph Theory, Representation Theory
- **Certifications:** Deep Learning Specialization (deeplearning.ai), Machine Learning Specialization (deeplearning.ai), SQL for Data Science (Coursera), Applied Social Network Analysis (Coursera)

PROFESSIONAL EXPERIENCE

Quantum Formalism — *Remote*
Mathematics Consultant
Nov. 2024 – Present

- Engineered hands-on computational exercises in Python notebooks demonstrating quantum and classical ML concepts using Scikit-learn, PyTorch, PennyLane, and SciPy.
- Designed and delivered advanced graduate-level curriculum bridging Lie Theory with practical Quantum Computing and Machine Learning applications (Course: [Lie Groups with Applications]).
- Developed visualization tools for dynamic simulation of quantum systems using Matplotlib and ipywidgets; applied concepts like Hamiltonian evolution, SU(4) decomposition, and error quantification.
- Built prototypes of ML pipelines for quantum gate classification and variational circuit optimization, leveraging gradient-based learning.

Institut de Mathématiques de Jussieu-Paris Rive Gauche — *Paris, France*
Postdoctoral Researcher
2023 – Sept. 2024

- Developed advanced mathematical models leveraging cutting-edge theoretical frameworks to analyze complex systems exhibiting irregular behavior.
- Contributed to a Fondation Sciences Mathématiques de Paris–funded project under the supervision of François Loeser.

University of Wisconsin–Madison — *Madison, WI*
Visiting Assistant Professor
2019 – 2023

- Developed and published a novel theoretical framework (Publ. RIMS Kyoto Univ.) extending advanced analytical techniques to model complex systems exhibiting irregular behavior.
- Secured a $5,000 AMS-Simons research grant by successfully proposing a novel approach to reformulate a complex, 40-year-old mathematical problem, integrating analytical and topological perspectives.
- Taught and designed curricula for undergraduate and graduate math courses, translating complex concepts into clear frameworks.

SELECTED PROJECTS

Math Research Compass: arXiv Trends Dashboard (GitHub [link]) (Website [link])

- Architected end-to-end data pipeline processing 133K+ mathematics preprints from arXiv, using Python, Pandas, and specialized NLP libraries to transform raw metadata into actionable research insights
- Implemented advanced topic modeling using BERTopic, UMAP, and HDBSCAN to identify and visualize coherent research topics across mathematical subfields
- Enhanced topic interpretability using Claude AI to generate human-readable topic labels and descriptions, significantly improving user experience
- Developed an interactive Shiny dashboard with Plotly visualizations that enables researchers to explore connections between 31 mathematical subfields
- Created a dynamic filtering system allowing users to explore research patterns by primary mathematical category, revealing concentrated areas of scholarly interest

Hamiltonian Simulation: TFIM via Trotterization (GitHub [link])

- Simulated time evolution of Ising models using matrix exponentiation and Trotter decomposition.
- Visualized quantum observable dynamics and linked numerical error to Lie bracket theory.
- Analyzed the superior convergence behavior of second-order Trotter methods, demonstrating the $O(t^3/N^2)$ vs $O(t^2/N)$ error scaling predicted by the Baker-Campbell-Hausdorff formula.

KAK Decomposition and Quantum ML (GitHub [link])

- Implemented Khaneja-Glaser algorithm for two-qubit gate decomposition and benchmarked against variational learning models.
- Demonstrated practical use of Cartan decomposition and automatic differentiation in PennyLane.
- Achieved near-perfect unitary approximation (~98% fidelity) using a parameterized quantum circuit that mirrors the mathematical structure of the Cartan decomposition for SU(4).

SELECTED PUBLICATIONS (Google Scholar [link])

- Hepler, Brian and Hohl, Andreas. “Moderate Growth and Rapid Decay Nearby Cycles via Enhanced Ind-Sheaves”, Publ. RIMS Kyoto Univ., Volume 61, no. 1 (To Appear, 2025)
- Hepler, Brian. “Deformation Formulas for Parameterized Hypersurfaces”, Annales de l’Institut Fourier, Volume 74 (2024) no. 3, pp. 1153–1188.

EDUCATION

Ph.D., Mathematics — Northeastern University, 2019
Specialization: Algebraic Topology, Computational Geometry
M.S., Mathematics — Northeastern University, 2014

B.A., Mathematics — Boston University, 2012
Cum Laude with Distinction in Mathematics