

# Nate Gillman

PhD Candidate at Brown University  
Departments of Computer Science, Mathematics

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## Research Interests

Mathematically Rigorous Generative Modeling, Machine Learning, Artificial Intelligence, Mathematics

## Education

**Ph.D.** (Machine Learning, Mathematics), Brown University Sept. 2020 – present

Advisor: Professor Chen Sun

Dissertation Committee: Professors Stephen Bach, Carsten Eickhoff, Jeffrey Hoffstein, Chen Sun

Awarded Sc.M. in Mathematics in May 2022

**B.A.** (Computer Science, Mathematics), Wesleyan University Sept. 2016 – May 2020

Honors: Class rank 1/748, Barry Goldwater Scholar, High Honors in Mathematics

## Publications/Preprints (Machine Learning)

- [1] **N. Gillman**, D. Aggarwal, M. Freeman, S. Singh, C. Sun.  
Fourier Head: Helping Large Language Models Learn Complex Probability Distributions  
Submission, under review [link]
- [2] **N. Gillman**, M. Freeman, D. Aggarwal, C. H. Hsu, C. Luo, Y. Tian, C. Sun.  
Self-Correcting Self-Consuming Loops for Generative Model Training  
In *International Conference on Machine Learning (ICML) 2024* [link]
- [3] W. Rudman, **N. Gillman**, T. Rayne, C. Eickhoff.  
IsoScore: Measuring the Uniformity of Embedding Space Utilization  
In *Findings of the Association for Computational Linguistics (ACL) 2022* [link]

## Publications (Pure Mathematics)

- [1] F. Coen, **N. Gillman**, T. Keleti, D. King, J. Zhu. Large sets with small injective projections, in *Annales Fennici Mathematici* (2021)
- [2] **N. Gillman**, M. Kural, A. Pascadi, J. Peng, A. Sah. Patterns of primes in the Sato-Tate conjecture, in *Research in Number Theory* (2020)
- [3] **N. Gillman**. Explicit subconvexity savings for sup-norms of cusp forms on  $\mathrm{PGL}(n, \mathbb{R})$ , in *Journal of Number Theory* (2020)
- [4] **N. Gillman**, X. Gonzalez, K. Ono, L. Rolen, M. Schoenbauer. From partitions to Hodge numbers of Hilbert schemes of surfaces, in *Philosophical Transactions of the Royal Society A* (2019)
- [5] **N. Gillman**, X. Gonzalez, M. Schoenbauer. Exact formulas for invariants of Hilbert schemes, in *Research in Number Theory* (2018)

## Selected Research Experience

**Machine Learning Research Intern**, Amazon Science Aug. 2024 – Dec. 2024

Improving physical realism of human-object interaction motion generative models.

**Machine Learning Research**, Brown University 2022 – present

Invented “Fourier Head”, a novel neural architecture which learns categorical distributions with a continuous structure, utilizing tools from Fourier analysis; used the architecture to improve a Decision Transformer agent’s returns by 46% (under submission at ICLR 2025)

Proposed the first technique for stabilizing self-consuming generative model training; used the technique to fix model collapse in the case of human motion generation using diffusion models; led team of 4 student researchers (ICML 2024)

Invented mathematically rigorous method for measuring uniformity of spatial utilization of word embedding spaces; used novel metric to disprove a number of recent conclusions in the NLP literature that have been derived using brittle metrics of isotropy (ACL 2022)

**Pure Mathematics Research**, Brown, Emory, Wesleyan, Budapest Semesters in Math 2016-2022

Studied modular forms and elliptic curves and other topics in analytic number theory; conjectured and proved theorems about distribution of primes; published 5 peer-reviewed math articles.

## Selected Industry Experience

**Machine Learning Engineer**, various companies June 2022 – May 2023

During yearlong leave of absence from PhD, built NLP chatbot at American Express AI labs; built audio generation and classification models (speaker separation, speaker diarization, voice cloning) at Captions, a video processing iOS app startup; and built probabilistic time series forecasting models at Akkio, an enterprise SaaS startup, and integrated them into web app.

## Service

**Teaching:** Mentoring junior machine learning researchers at Brown (2022–present), Brown mathematics teacher training (2021), mentored a directed reading program in cryptography (2021), course assistant for algebra, analysis, calculus, discrete math, number theory (2017-2022), math research seminar organization (2020-2021)

**Outreach:** organized activities “Numbers in Nature with Nate”, “Math Yoga” at youth summer camps.

**Peer reviewing:** ECCV, NeurIPS, ICLR, Research in Number Theory.

## Selected Invited Talks

[1] *Mode Collapse in Self-Consuming Generative Models*, Math ML Seminar at MPI and UCLA

[2] *Self-Correcting Self-Consuming Loops for Generative Model Training*, NYC Computer Vision Day 2024