# NOAH J. BERGAM

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## Education

**Columbia University** — **New York, NY**
Mathematics Major. GPA: 4.15/4.33. — 2021 - 2024

**The Pingry School** — **Basking Ridge, NJ**
Valedictorian. Senior Class President. SAT: 1590. — 2017 - 2021

## Research

(*) indicates paper in progress

*Interests: machine learning theory, unsupervised learning, computational geometry, algorithms for massive data.*

(*) **N. Bergam**, B. Csatho, and A. Patra. A graph-theoretic approach to altimetry-based surface modeling of the Greenland ice sheet. Joint Math Meeting, Poster Presentation. 2024.

(*) **N. Bergam** and N. Verma. On optimal t-distributed stochastic neighbor embeddings. UMD College Park Fall Fourier Talks, Poster Presentation. 2023.

**N. Bergam**. Regression on Ice: Function Approximation for the Mathematically-Inclined Glaciologist. The GHub. 2023.

W. Yang, **N. Bergam**, A. Jain, and N. Sheikhoslami. Confidence-Calibrated Ensemble Dense Phrase Retrieval. Preprint arXiv:2306.15917. 2023.

**N. Bergam**, E. Allaway, and K. McKeown. Legal and political stance detection of SCOTUS language. Natural Legal Language Processing Workshop, EMNLP. 2022.

**N. Bergam** and T. Kolarov. The Black-Scholes model in the context of econophysics. Parabola Math Journal, University of New South Wales. 2021.

**N. Bergam**, L. Chen, S. Lende, S. Snow, J. Zhang, M. DiBuono, and N. Calzaretto. Designing and Simulating a Smart Air Purifier to Combat HVAC-induced COVID-19 Transmission. MIT IEEE URTC, IEEE Xplore. 2020.

## Research Experience

[**Honors Senior Thesis**] **Manifold Dimension Estimation.** — New York, NY
Columbia Mathematics Department. Advisor: Andrew Blumberg. — Fall 2023 - Present

- Reviewing algorithms for intrinsic dimension estimation of point cloud data sampled from a smooth manifold. Interested in the (under-explored) active learning regime, where points are sampled adaptively rather than i.i.d.

[**Tufts REU**] **Adaptive Triangulation for Geostatistics.** — Medford, MA
Tufts Mathematics Department, Data Intensive Studies Center. Advisor: Abani Patra. — Summer 2023 - Present

- Tested and analyzed a new "adaptive triangulation" scheme for altimetry modeling of the Greenland ice sheet. This algorithm is more efficient and lower-error than the grid-based schemes usually deployed in this setting.
- Published lecture notes on the mathematics of regression, in collaboration with NSF-funded Glaciology Hub.

[**Pritzker-Pucker Scholar**] **Theoretical Analysis of t-SNE.** — New York, NY
Columbia Computer Science. Advisor: Nakul Verma. — Spring 2023 - Present

- Interested in the complexity of optimizing the objective for t-distributed stochastic neighbor embeddings (t-SNE).
- Established necessary and sufficient conditions for the existence of optimal embeddings. Proved NP-hardness of a simplified version of t-SNE. New proof of t-SNE's agreement with spectral clustering for low-diameter embeddings.

[**Laidlaw Scholar**] **NLP-driven Analysis of Supreme Court Hearings.** — New York, NY
Columbia Computer Science. Advisor: Kathleen McKeown. — Summer 2021

- Used transformer-based language models to track the political stance expressed in Supreme Court transcripts from 1950 to 2020. Found correlations between this NLP-based stance metric and voting behavior among the justices.
- Using SCOTUS written opinions, created and trained models on a *legal stance detection* dataset, the first of its kind.

**[Yeshiva REU] Topological Data Analysis for NLP** New York, NY

Yeshiva University Mathematics Department. Advisor: Marian Gidea. Summer 2020

- Used persistent homology on word embeddings to construct an author classification model. Took mini-courses in change point detection and stochastic interacting particle systems.

## Work Experience

**Teaching Assistant** New York, NY

Columbia Computer Science Department Fall 2022 - Present

- I hold office hours, run review sessions, and grade assignments for graduate-level computer science courses.
  - Fall 2023: TAIII for COMS4771: Machine Learning. Instructor: Daniel Hsu
  - Spring 2023: CA for COMS4771: Machine Learning. Instructor: Nakul Verma
  - Fall 2022: CA for COMS4705 Natural Language Processing. Instructor: Daniel Bauer.

**Residential Advisor** New York, NY

Columbia Residential Life Fall 2022 - Present

- Community leader for around 40 undergraduate residents. Regularly on-duty to help handle emergencies and other concerns from residents. Trained to connect students with various campus resources.

**NLP Research Engineering Intern** New York, NY

NLMatics Co. Summer 2022

- Used large language models to enhance knowledge-gathering for law, medicine, and finance practitioners.
- Improved state-of-the-art phrase retrieval benchmarks using confidence calibration and ensembling.

## Activities

**Content Editor for the Columbia Journal of Undergraduate Mathematics** Fall 2023 - Present

- Expository journal, by and for undergraduates. I write referee reports for submissions.
- I have also been providing comments for Dr. Loring Tu as he edits his 3rd edition of *Introduction to Manifolds*.

**Vice President of Columbia Men's Club Water Polo Team** Fall 2022 - Present

**Presenter for the Columbia Undergraduate Mathematics Society** Spring 2021 - Present

- Past talks include: *The Duality of Determinant and Trace* (Summer 2023); *On t-SNE's spectral regime* (Spring 2023); *Coins, Partitions, and Generating Functions* (Summer 2022); *Statistical Mechanics Helps Us Count Alternating Sign Matrices* (Fall 2022); *Topological Insights on Vector-Embedded Language* (Spring 2022).

## Fellowships and Awards

- Van Amridge Mathematical Prize (2023), i.e. top-four scorer on Columbia Math Prize Exam.
- Laidlaw Leadership and Research Scholar (2023).
- Pritzker-Pucker Summer Funding Awardee (2023).
- 2x NSF REU participant (2021, 2023).
- Best in Data Science and Society at Columbia Undergrad CS and Data Science Fair (2022).
- National Merit Scholarship Finalist (2021).
- National AP Scholar (2021).
- Brown University Book Award; The Physics Award; Casmir A. France Award for Excellence in English (2021).
- Winner (2019) and Finalist (2020) in the LeBow Oratorical Competition.
- Congressional App Challenge Winner (2020). Submission: The Digital Humanities Lab.
- People's Choice Lightning Talk Award at the MIT IEEE Undergrad Research in Technology Conference (2020). Title: DROVER: Drone-Rover Communication for Pathfinding.