# Selma Mazioud

New Haven, CT selma.mazioud@yale.edu (475) 287-9005 selma-m.github.io

## Summary

I am a senior at Yale College studying Applied Mathematics, and concentrating in the study of Machine Learning. I have experience conducting independent research projects and education. I am interested in the mathematical foundations of machine learning and in statistical learning models that rely on a geometric understanding of the data (including graph neural networks), with applications in high-energy physics and biomedical sciences.

## Education

**Yale University** *Sept 2021 – May 2025*
*BS in Applied Mathematics*
**GPA:** 3.86/4.0
**Skills:** Python, C++, C, R, NumPy, SciPy, PyTorch, PyG, CVXPY.

## Research Interests

Geometric Deep Learning, Graph Signal Processing, Manifold Learning, ML for physics, foundations of AI/ML.

## Publications, presentations, and preprints

**Exploring the Manifold of Neural Networks using Diffusion Geometry** October 2024
Elliott Abel*, Drew Steindl*, **Selma Mazioud***, Ellie Schueler*, Folu Ogundipe*, Ellen Zhang, Yvan Grinspan, Kristof Reimann, Peyton Crevasse, Dhananjay Bhaskar, Kaly Zhang, Tim Rudner, Ian Adelstein, Smita Krishnaswamy.
*Under review*, 28th International Conference on Artificial Intelligence and Statistics (AISTATS 2025). arXiv

**Sequentially Charming Chemical Freeze-out in Relativistic Heavy Ion Collisions at the LHC and RHIC** October 2024
Fernando Flor, **Selma Mazioud**.
2024 Fall Meeting of the American Physical Society, Division of Nuclear Physics. Abstract

**Statistical Hadronization Model Calculations of Heavy Flavor Hadron Production in Relativistic Heavy-Ion Collisions at RHIC and the LHC** September 2023
**Selma Mazioud**, Fernando Flor.
XXXth International Conference on Ultra-relativistic Nucleus-Nucleus Collisions. Abstract and poster.

## Research experience and projects

**Wu Tsai Institute** Krishnaswamy Laboratory. June 2024—present

- **Senior project.** *Measuring Entropy in Graph Datasets Using Geometric Scattering and Diffusion Geometry.* Advised by Yale Professors Smita Krishnaswamy and Ian Adelstein.
  - Proposed a novel method to compute entropy over a set of graphs, providing a statistic that quantifies the variability of a graph dataset
  - Demonstrated that our method effectively captures the variance of a graph dataset through experiments on toy datasets generated by increasingly perturbing a graph.
- **Yale REU.** *Exploring the Manifold of Neural Networks Using Diffusion Geometry.* Advised by Yale Professors Smita Krishnaswamy and Ian Adelstein.
  - Showed that high-performing neural networks, across architectures, exhibit higher diffusion spectral entropy in their hidden embeddings of the data.
  - Using the eigenspectrum of the manifold graph Laplacian, showed that test accuracy and learning rate are low-frequency signals, which indicates we are able to interpolate in the space of neural networks to choose parameter ranges.

**Wright Laboratory**. Relativistic Heavy-Ion Group (Caines Group). May 2023—present

- **Class project.** *Graph-based Machine-Learning Methods for Particle Reconstruction at the LFHCal.* Advised by Yale Professor Helen Caines (ongoing).
  - Utilize a trainable adjacency matrix to embed node features into a highly expressive latent space where clustering is easier to deploy.
- **Research project for credit.** *Machine-Learning Methods for Particle Reconstruction at the LFHCal.* Advised by Yale Professor Helen Caines.
  - Demonstrated that an integrated approach combining quadratic regression and k-means clustering not only attained high accuracy but also exhibited remarkable robustness against Gaussian noise.
- **Yale REU.** *Statistical Hadronization Model Calculations of Charm Hadron Production in Relativistic Heavy Ion Collisions at the LHC.* Advised by Yale Professor Helen Caines.
  - Modeled the relationship between fugacity factor, which accounts for the production of charmed hadrons resulting from the initial collision scattering, and temperature of chemical freezeout.
  - Showed that charm quarks hadronize at higher temperature than strange and light quarks.

## Fellowships and awards

McCall MacBain Scholarship Finalist; 2025
Summer Undergraduate Research in Mathematics at Yale (SUMRY) fellowship; 2024
Yale Richter fellowship (Summer Undergraduate Research Fellowship); 2023, 2024

## Teaching Experience

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| **Undergraduate Learning Assistant for Theory of Statistics** | Spring 2025 |
| **Undergraduate Learning Assistant for Introductory Machine Learning** | Fall 2024 |
| **Undergraduate Learning Assistant for Algorithms** | Spring 2024 |
| **Course-based Peer Tutor for Calculus II** | Fall 2023, Spring 2024 |
| **Undergraduate Learning Assistant for Data Analysis and Exploration** | Spring 2023, Fall 2023 |
| **French Language Tutor** | Fall 2022, Spring 2023 |

## Work experience

**Tsai Center for Innovation Thinking at Yale**, *Venture Pathway Coordinator* August 2022—May 2023
**Capgemini**, *Software Engineering Intern* May—July 2022

- Developed image processing methods using Sobel's, the Laplacian, and the watershed algorithms.
- Designed an efficient implementation of the Levenshtein algorithm adapted to French characters, learned to navigate a Linux environment.

## Service and Leadership

**Applied Mathematics Departmental Student Advisory Committee**, *Member* Fall 2024, Spring 2025
**Summer Undergraduate Mathematics Research at Yale**, *Diversity Equity & Inclusion Committee Chair* Summer 2024
**Middle Eastern and North African Student Association**, *Senior Advisor* August 2022—Present

- Previously President and Advocacy Chair.
- When I got to Yale, there were only 4 cultural centers, none of which captured the complexity of the MENA identity, left institutionally under-resourced. Alongside peers I helped create a 5th center that my community could belong in in my quest for my own cultural identity.
- Secured a $60,000 budget for Yale's first full MENA space (the first of its kind in the Ivy League) and hired a full-time MENA Assistant Director. Yale President Announcement. The Yale Daily News. The Yale Daily News. The Yale Herald.