Selma Mazioud

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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 manifolds and graph neural networks), with applications in high-energy physics, biomedical sciences, and sustainable development.

Education

Yale University *Sept 2021 – May 2025*
BS in Applied Mathematics

GPA: 3.84/4.0
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, Peyton Crevasse, Yvan Grinspan, **Selma Mazioud**, Folu Ogundipe, Kristof Reimann, Ellie Schueler, Drew Steindl, Ellen Zhang, 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
Fernando Flor, **Selma Mazioud**.
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 (ongoing).** *Expressivity of Graph Embeddings via Geometric Scattering using Diffusion Geometry.* Advised by Yale Professors Smita Krishnaswamy and Ian Adelstein.
  - Show that geometric scattering creates more expressive embeddings of graphs than vanilla graph neural networks.
  - Design a method to compute entropy over a set of graphs using geometric scattering and diffusion spectral entropy.
- **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 (ongoing).** *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

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.