Mathis Hardion

PhD candidate at the Gustave Eiffel University

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Mathis Hardion
mhardion

Interests

Optimal transport and its entropic regularization, gradient flows in metric spaces, analysis of PDEs, geometry on the space of probability measures, machine learning and sampling methods.

Education

2025 - **PhD in mathematics**
Gustave Eiffel University, LIGM (Champs-sur-Marne, France)
Working title: *Optimization through optimal transport with entropic regularization.* Supervised by Théo Lacombe and François-Xavier Vialard.

2023 - 2024 **MSc in mathematics, vision, learning (MVA)**
École Normale Supérieure de Paris-Saclay (Gif-sur-Yvette, France)
Research-oriented degree in machine learning through a mathematical lens, wide spectrum of courses followed in the above domains of interest.
Thesis: *Gradient Flows in the Geometry of the Sinkhorn Divergence.* Supervised by Hugo Lavenant (Bocconi University).

2020 - 2024 **Engineering degree (Diplôme d'ingénieur)**
Télécom Paris (Palaiseau, France)
Specialization in Stochastic Modelling and Numerical Analysis, Signal Processing and Machine Learning.

2018 - 2020 **Classe Préparatoire au Grandes Écoles (MPSI, MP*)**
Lycée Carnot (Dijon, France)
Intensive two-year program giving rigorous training in preparation for national competitive exams allowing entry into top French graduate schools. Specialization in Mathematics, Physics and Computer Science.

Research experience

2024 (6 months) **Research Intern**
Bocconi University (Milan, Italy)
Gradient Flows in the Geometry of the Sinkhorn Divergence: derivation of the differential equation corresponding to the gradient flow of a potential energy, its main properties and long-time behavior, numerical implementation and comparison with the Wasserstein case. Entropic Optimal Transport, Gradient Flows, Functional Analysis, Riemannian Geometry, RKHS, Numerical Optimization & Visualization (Python).

2023 (2 months) **Front Office Support**
Axpo Solutions AG (Brussels, Belgium)
Constrained algorithmic financial optimization of multi-asset heat, power and CO2 production schedules for greenhouses. Applied research, Mathematical modelling, Numerical optimization (python, LP/MILP, Simulated annealing, Evolutionary algorithm), FTP communication, Predictive price curve evaluation and comparison.

Preprints

[1] M. Hardion and H. Lavenant. Gradient Flows of Potential Energies in the Geometry of Sinkhorn Divergences, 2025. arXiv: 2511.14278 [math.AP]. Submitted.

Other research projects

Some of the reports and presentations made during my MSc can be found in the "MSc projects" section of my website, including the following:

Reports:

Neural Optimal Transport

Variational Learning of Inducing Variables in Sparse Gaussian Processes

Generalized Sliced Distances for Probability Distributions

Sparse representation of multivariate extremes with applications to anomaly detection

Mean Curvature Motion of Point Cloud Varifolds

Presentations:

Riemanniann Manifold Hamiltonian Monte Carlo

FibeRed: Fiberwise Dimensionality Reduction of Topologically Complex Data with Vector Bundles

Other work experience

2021 (2 months) **Education Intern**

Learning Robots (Gif-sur-Yvette, France)

Design and improvement of high-school and post-secondary level practical sessions and videos teaching artificial intelligence algorithms and ethics through robots. Development of new features for the AlphAI robot and software (Python).

Languages

French: Native

English: Proficient (C1)

German: Intermediate (B1)