Sofiane Ezzehi

PhD student in Applied Mathematics

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Research interests

Model order reduction for nonlinear parametric problems; variational inequalities; hyper-reduction; semi-smooth Newton methods; scientific machine learning (neural-network-augmented reduced models, neural PDE solvers).

Education

2024 – 2027 (expected) **PhD in Applied Mathematics** — Marne-la-Vallée, France

CERMICS, École nationale des ponts et chaussées – Modelling, Analysis and Simulation (MAS) group, in collaboration with IFP Energies nouvelles (IFPEN).
Topic: Model order reduction for nonlinear parametric variational inequalities, with applications to CO_2 storage simulation.
Advisors: Virginie Ehrlacher (CERMICS) and Guillaume Enchéry (IFPEN).
Member of the MATHERIALS project-team, Inria Paris.

2023 – 2024 **MSc Mathématiques, Vision, Apprentissage (MVA)** — Paris, France

École normale supérieure Paris-Saclay. Average grade: 18.2/20.
Selected courses: computational statistics, probabilistic graphical models, reinforcement learning, graphs in machine learning, geometric data analysis.

2020 – 2024 **Engineering degree (Diplôme d'ingénieur)** — Paris, France

École nationale des ponts et chaussées – Department of Applied Mathematics and Computer Science.
Selected courses: Fourier analysis, convex optimisation, evolution problems, high-dimensional statistics, analysis and scientific computing.

Publications and preprints

2026 **S. Ezzehi**, V. Ehrlacher, G. Enchéry and T. Faney. *A hyper-reduced neural network-augmented semi-smooth Newton method for nonlinear parametric variational inequalities.* Preprint, arXiv:2607.21242.

Research experience

Oct 2024 – present **Doctoral researcher, CERMICS & IFPEN** — Marne-la-Vallée, France

- Reduced-order models for parametric variational inequalities arising in porous media with faults, motivated by CO_2 storage simulations.
- Combination of projection-based reduction (POD), neural-network-augmented reduced models and hyper-reduction within a semi-smooth Newton framework.

Apr 2024 – Jul 2024 **Research intern, CERMICS** — Marne-la-Vallée, France

Galerkin neural networks.

- Literature review of neural-network PDE solvers: PINNs, Deep Ritz, VPINNs, Galerkin neural networks.
- Implementation and comparative study on 2D Poisson problems on regular and irregular domains.

Sep 2022 – Feb 2023 **Research intern, CEA** — Paris-Saclay, France

Coupled thermo-neutronic problem.

- Development of a shooting-method algorithm extending the analysis of the coupled problem to molten salt reactors.

Talks and posters

Contributed talks

Jun 2026 CANUM 2026, 47th French National Congress on Numerical Analysis, Saint-Jacut-de-la-Mer.
Jun 2025 ADMOS 2025, XII Int. Conference on Adaptive Modeling and Simulation, Barcelona, Spain.
Feb 2025 DTE & AICOMAS 2025, Arts et Métiers Institute of Technology, Paris, France.

Posters

Dec 2025 — Workshop on Industrial Applications of Numerical Analysis and Machine Learning, CWI, Amsterdam, Netherlands.

Jul 2024 — Workshop SciML on Scientific Machine Learning, Université de Strasbourg, France.

Honours and awards

2025 — **Poster Prize**, Workshop on Industrial Applications of Numerical Analysis and Machine Learning, CWI Amsterdam.

2022 — 4th of 60 teams, KIRO operations research challenge (École des ponts, CERMICS and Pelico).

2020 — **French Government Scholarship**, Ministry for Europe and Foreign Affairs – one of 8 awarded for results in the Grandes Écoles entrance exams (tuition and living expenses).

Teaching and supervision

Teaching, École nationale des ponts et chaussées (76 h in total)

Feb – Apr 2026 — **Practice of machine learning methods (PRAMA)** — 12 h
Practical sessions in Python. Random forests, gradient boosting, support vector machines and neural networks applied to real datasets.

Nov 2025 – Jan 2026 — **Analysis and PDEs, Part I (first-year course)** — 20 h
Lectures and exercise sessions. Normed vector spaces, Banach and Hilbert spaces, measure theory and Lebesgue integration.

Nov 2024 – Jan 2025 — **Analysis and PDEs, Part II (first-year course)** — 20 h
Lectures and exercise sessions. Lebesgue spaces, Fourier series, distribution theory, Fourier transform.

Supervision of first-year research projects, École nationale des ponts et chaussées

Feb – May 2026 — **Neural networks for solving partial differential equations** — 12 h
Proposed and supervised the project. Neural networks implemented in Python, then used to solve 1D/2D PDEs with physics-informed neural networks (PINNs) and the Deep Ritz method; design and validation of numerical experiments against classical methods.

Feb – May 2026 — **Model order reduction: POD and hyper-reduction (DEIM)** — 12 h
Proposed and supervised the project. Finite element solution of simple parametric PDEs (variational formulation, Lax–Milgram, Galerkin method), then construction of hyper-reduced reduced-order models with POD and DEIM, implemented in Python.

Schools and workshops attended

Jan 2026 — XXII Jacques-Louis Lions Winter School on Numerical Simulation in Physics and Engineering, Institut Henri Poincaré, Paris.

Oct 2025 — Autumn School on Scientific Machine Learning and Numerical Methods, CWI, Amsterdam.

Jun 2024 — CEA–EDF–Inria Summer School on Model Reduction, EDF Lab, Palaiseau.

Scientific service

2026 — Member of the organizing committee, CJCMA 2026 (Congrès des Jeunes Chercheurs en Mathématiques Appliquées), École des ponts.

Skills

Scientific computing — Finite element methods, reduced-basis and POD methods, hyper-reduction, semi-smooth Newton solvers, neural PDE solvers.

Languages — French (bilingual), English (fluent), Arabic (native: Tunisian; fluent: Modern Standard), Spanish (elementary).

References

Virginie Ehrlacher (PhD advisor)
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Guillaume Enchéry (PhD co-advisor)
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