

Elisa Riccietti

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Research interests

I am associate professor (maître de conférences) at ENS Lyon. My research bridges **numerical optimization**, **imaging**, and **machine learning**, with contributions to multilevel and hierarchical methods, sparse matrix factorization, mixed precision optimization, quantized neural networks.

I have participated to and led national and international projects (e.g., ANR JCJC MEPHISTO), co-supervised 9 PhD students and 2 postdoc students, and co-authored 42 publications in leading journals such as SIAM Journal on Optimization, IEEE Transactions on Information Theory, and SIAM Journal on Imaging Sciences, and a book chapter.

Selected contributions:

- Developed multilevel optimization algorithms for deep learning and inverse imaging problems to accelerate the solution of large scale problems.
- Designed efficient direct hierarchical algorithms for fixed support matrix factorization problems.
- Introduced mathematically founded mixed precision methods.

Short bio

Associate professor (maître de conférences)

Ecole Normale Supérieure (ENS) de Lyon, LIP

(Maternity leave from 27/07/2023 to 15/11/2023)

Lyon, France

2020–ongoing

Postdoc researcher

Institut de Recherche en Informatique de Toulouse (IRIT), ENSEEIHT

Toulouse, France

2017–2020

PhD in Applied Mathematics

Università degli Studi di Firenze, Department of Mathematics

Firenze, Italy

2014–2017

Awards

Personal awards

- Best paper award: “On the approximation of PDEs solution by ANNs trained by a multilevel Levenberg-Marquardt method”, Summer School on Optimization, Big Data and Applications (OBA), Veroli, Italy, 2019.
- Master thesis prize “Hansjörg Wacker Memorial Prize”, jointly funded by ECMI (European Consortium of Mathematics in Industry) and by a consortium of institutions from Linz, 2016

Students' awards

- Best poster award for Edgar Desainte-Mareville at the 2026 PhD Summer School on Mathematics and Machine Learning for Image Analysis in Bologna.
- Honorable mention for the PhD thesis of Antoine Gonon in the 2025 PhD thesis award in machine learning from the Société Savante Francophone en Apprentissage Machine (SSFAM).

Professional activities

Research leadership

- Principal investigator of the MOMIGS project on multilevel optimization, funded by GDR ISIS for 7000 euros (2020-2023). Aim: study of multilevel schemes to accelerate image reconstruction.
- Principal investigator of the ANR JCJC project MEPHISTO on hierarchically structured optimization, funded for 278000 euros (2024-2028). Aim: development of scalable hierarchical optimization algorithms for machine learning and inverse problems.

Participation to projects

- Member of the ANR project PINOT on physics informed reconstruction of ocean turbulence (2025-2029).
- Member of the PEPR SHARP project on parsimonious learning (2024-2030).
- Member of the DI2A Fondazione Cino del Duca project on image reconstruction (2023-2025).

Scientific responsibilities

- Member of the "Commission formation du Labex MILyon" (2022-2025).
- Member of the "Conseil scientifique de la FIL" (since 2022).

Teaching responsibilities

- Member of the commission for the creation of the master M2 "maths en Action", proposition of the program for the course "Optimisation et Machine Learning" (2023).
- Coordinator of the M1 internships program at DI, ENS Lyon (since 2023).
- Member of the commission for the program reform of L3 and M1 of DI-ENS Lyon (2020-2021).
- Member of the committee for the creation of the "Cycle pluridisciplinaire d'études supérieures (CPES), Sciences et Société" of Lycée du Parc and ENS Lyon (2022-2023).

Participation to working groups

- Journée de l'Intelligence Artificielle Lyon Saint-Étienne - Atelier IA & Frugalité, Lyon, 12/11/2025.

Events organization

- Organiser of the workshop "STOP: structured optimization for inverse problems and machine learning" at ENS Lyon, 2026.
- Organiser of the mini-symposium "Challenges and recent advances in multilevel optimization" at SIOPT 2026.
- Co-organiser of the "Journées SMAI-MODE", Lyon, 2024.
- Co-organiser of the workshop DIPOpt, Lyon, 2023.
- Co-organiser of the "Journées IXXI", Lyon, 2023.
- Co-organiser of the mini-symposium "Multiresolution and multilevel methods in imaging" at SIAM CSE 2023.
- Co-organiser of the mini-symposium "Low-Rank Models and Algorithms for Matrix Optimization" at SIOPT 2023.
- Co-organiser of the mini-symposium "Advances in Krylov methods for nonlinear optimization", SIAM LA 2021.
- Co-organiser of the mini-symposium "Efficient numerical solution of nonconvex problems" at ICCOPT 2019.
- Co-organiser of the mini-symposium "Iterative linear algebra for optimization problems" at IMA Conference on Numerical Linear Algebra and Optimization 2020.
- Co-organiser of the summer school "IAoundé" à Yaoundé (Cameroun) 2020.
- Co-organizer of the mini-symposium "Inverse Problems in Geophysics" at University of Florence, 2016.

Participation to selection committees.....

- Participation to the selection committee for the MCF concours (section n° 27) at ENS Lyon, 2026.
- Participation to the selection committee for the recruitment of an ATER position (section n° 25), ENS Lyon, 2023 and 2024.
- Participation to the selection committee for the MCF concours (section n° 25) at ENS Lyon, 2023.
- Participation to the selection committee for the MCF concours (section n° 26) at University of Nice, 2023.
- Participation to the selection committee for the DODOU prix, journées SMAI-MODE 2023, Limoges.

Participation to juries.....

- Participation to the jury of the PhD thesis defence of Iskander Legheraba, 26/09/2025, Dauphine, Paris.
- Participation to the jury of the PhD thesis defence of six PhD students at the University of Florence, 2020.
- Participation to the jury of the M1 and M2 internships at DI-ENS Lyon (every year from 2020).

Teaching

- *Harnessing inexactness in scientific computing*, DI-ENS Lyon, 2023-ongoing (20heqTD/year).
- *Machine Learning*, M1, DI-ENS Lyon, 2021-ongoing (20heqTD/year).
- *Optimization and Approximation*, M1, DI-ENS Lyon, 2020-ongoing (20heqTD/year).
- *Data science and big data*, Formation Toulouse Tech, Toulouse, 2018-2020 (140h).
- *Data analysis*, ENSEEIHT, Toulouse 2020 (20heqTD).
- *Scientific Computing*, IRIT, Toulouse, 2018-2020 (48heqTD).
- *Integration and Applications*, IRIT, Toulouse, 2018 (7h).
- *Scientific Computing*, Università degli Studi Firenze, 2016 (22h).

Supervision of students

Supervision summary: **9 PhD students** (3 ongoing), **2 postdocs**.

PhD students.....

- Giuseppe Carrino, ENS Lyon (2025-ongoing). Co-supervised by myself (33%), Nicolas Brisebarre (33%, director, DR CNRS LIP), Theo Mary (33% CR CNRS LIP6). Topic: mixed precision optimization.
- Mael Chaumette, ENS Lyon (2024-ongoing). Co-supervised by myself (50%), Rémi Gribonval (50%, director, DR INRIA LIP). Topic: quantization of neural networks.
- Edgar Desainte-Maréville, ENS Lyon (2024-ongoing). Co-supervised by myself (33%, director with derogation), Paulo Gonçalves (33%, director, DR INRIA LIP), Nelly Pustelnik (33%, CR CNRS ENSL). Topic: multilevel optimization for imaging problems.
- Filippo Marini, Università di Bologna (2022-2025). Co-supervised by myself (50%) and Margherita Porcelli (50%, director, UNIFI). Topic: stochastic multilevel optimization.
- Valentin Mercier, IRIT, Toulouse (2021-2024). Co-supervised by myself (50%) and serge Gratton (50%, director, IRIT). Topic: multilevel methods for PINNs.
- Guillaume Lauga, ENS Lyon (2021-2024). Co-supervised by myself (33%, director with derogation), Paulo Gonçalves (33%, director, DR INRIA LIP), Nelly Pustelnik (33%, CR CNRS ENSL). Topic: multilevel optimization for imaging problems.
- Léon Zheng, ENS Lyon - Valeo (2021-2024). Co-supervised by myself (25%), Rémi Gribonval (25%, director, DR INRIA LIP), Patrick Perez (25%, director, VALEO), Gilles Puy (25%, VALEO). Topic: sparse matrix factorization.

- Antoine Gonon, ENS Lyon (2021-2024). Co-supervised by myself (25%), Nicolas Brisebarre (33%, DR CNRS LIP), Rémi Gribonval (25%, director, DR INRIA LIP). Topic: mathematical study of neural networks.
- Quoc Tung Le, ENS Lyon (2020-2023). Co-supervised by myself (50%), Rémi Gribonval (50%, director, DR INRIA LIP). Topic: sparse matrix factorization.

Postdoctoral students.....

- Nilo Schwenke, ENS Lyon (2026-2028). Co-supervised by myself (50%) and Nelly Pustelnik (50%, CR CNRS ENSL). Topic: multilevel natural gradient methods.
- Nils Laurent, ENS Lyon (2023-2024). Co-supervised by myself (25%), Nelly Pustelnik (33%, CR CNRS ENSL), Julian Tachella (33%, CR CNRS ENSL). Topic: multilevel plug and play methods.

Invited talks

- Link between multilevel and block coordinate descent methods in imaging, EUROPT conference, Linz, Austria, 08/07/2026-10/07/2026
- Frequency-aware multigrid training of Physics-Informed Neural Networks, EMS TAG SciML 2026, Koln, Germany, 10/03/2026
- Frequency-aware training of Physics-Informed Neural Networks: a multilevel approach, Journée AILYS at ENS Lyon, 14/02/2025
- Exploiting multiple resolutions to accelerate inverse problems in imaging, Mathematics and Image Analysis (MIA'25) conference, Paris, 13/01/2025-15/01/2025.
- Structure exploiting hierarchical optimization methods, Journée POPILS, INSA Lyon, 16/02/2024.
- Frequency aware training of Physics-Informed Neural Networks: a multilevel approach, Journée d'équipe EMS, Université d'Orleans, 12/09/2024.
- Multilevel methods in optimization, Seminar at Avignon University, 29/09/2022.
- Fixed support sparse matrix factorization: identifiability and tractability, LRMA workshop, Mons, Belgium, 15/09/2022-16/09/2022.
- Multilevel optimization methods, Seminaire du Laboratoire Jacques-Louis Lions, Paris, 20/05/2022.
- Optimization strategies to deal with large-scale problems: an opportunity for mixed precision? Seminar in Taran team meeting, Rennes, 08/03/2022.
- Multilevel PINNS for PDEs, 13th JLESC Workshop, 14/12/2021-16/12/2021.
- Second order optimization methods for the solution of large scale nonlinear noisy problems, PRIMO talk, online seminar, 15/10/2020.
- High-order multilevel optimization strategies and their application to the training of artificial neural networks, Seminar SPOT, Toulouse, France, 11/03/2019.
- Particle swarm optimization for the optimization of energy districts, 19th European Conference on Mathematics for Industry (ECMI), 13/06/2026-17/06/2016.

Publications

I have authored a total of **42 articles**: 30 articles in international revues (21 in journals, 9 in conferences), 8 articles in national conferences and 4 preprints.

During my PhD thesis at the University of Florence (supervised by S. Bellavia), I have been working on regularization methods for inverse problems, and published in top optimization journals such as Computational Optimization and Applications (COAP, Q1, H91), Journal of Optimization Theory and Applications (JOTA, Q1, H105), Numerische Mathematik (Q1, H101), Inverse problems (Q1, H133). The order of the authors is alphabetical, as common in the mathematical community (articles 12-14 and 17). I have also published two

papers (articles 15 and 16) in the engineering journal *Engineering Optimization* (Q2, H79), in collaboration with some engineering colleagues, where I am the first author.

During my postdoc, in collaboration with H. Calandra from Total and my supervisors S. Gratton (IRIT) and X. Vasseur (ISAE-SUPAERO), I have been working on multilevel methods for the training of neural networks and published in optimization journals such as *SIAM Journal on Optimization* (Q1, H152), *SIAM Journal on Matrix Analysis and Applications* (Q1, H113), *Optimization Methods and Software* (Q2, H70). The order of the authors is still alphabetical (articles 9-11).

When I joined ENS Lyon in 2020, I widened my research interests and started working on sparse matrix factorization, imaging problems, quantization, mixed precision, and mathematical theory of neural networks, with my colleagues N. Brisebarre, P. Gonçalves, R. Gribonval, N. Pustelnik, J. Tachella from ENS Lyon, and published (articles 1-8) in *SIAM Journal on Mathematics of Data Science* (Q1), *IEEE Transactions on Information Theory* (Q1, H304), *SIAM Journal on Imaging Sciences* (Q1, H87). During this period, I also started publishing in international signal processing (EUSIPCO, ICCASP, all rank B) and machine learning (NEURIPS, ICLR, ICML, all rank A*) conferences, as well the national conference GRETSI. The order of the authors for both the journals and the conferences is the one typically used in signal processing (first the students, then the supervisors), with the exception of articles that are in collaborations with colleagues from other institutions and where the order is alphabetical.

Book chapters.....

1. A. Kopaničáková & E. Riccietti, Introduction to optimization methods for training SciML models, in *A smooth introduction to SciML: Mathematical foundations and numerical implementation*, submitted to Cambridge University Press, 2026.

Journal Articles.....

1. QT. Le, L. Zheng, E. Riccietti & R. Gribonval, Rapture of the deep: highs and lows of sparsity in a world of depths, accepted for publication in *IEEE Signal Processing Magazine*, 2025.
2. EM. El Arar, SI. Filip, T. Mary & E. Riccietti, Mixed precision accumulation for neural network inference guided by componentwise forward error analysis, To appear in *IMA Journal of Numerical Analysis*, 2026.
3. F. Marini, M. Porcelli & E. Riccietti, A multilevel stochastic regularized first-order method with application to finite sum minimization, To appear in *Mathematics of computation*, 2026.
4. N. Laurent, J. Tachella, E. Riccietti & N. Pustelnik, Multilevel Plug-and-Play Image Restoration, *IEEE Transactions on Computational Imaging*, 2025.
5. QT. Le, L. Zheng, E. Riccietti & R. Gribonval, Butterfly factorization with error guarantees, *SIAM Journal on Matrix Analysis and Applications*, 46(4): 2253–2309, 2025.
6. L. Cocchi, F. Marini, M. Porcelli & E. Riccietti, Black-box optimization for the design of a jet plate for impingement cooling, *Optimization and Engineering*, 2025.
7. S. Gratton, V. Mercier, E. Riccietti & Ph.L. Toint, A Block-Coordinate Approach of Multi-level Optimization with an Application to Physics-Informed Neural Networks, *Computational Optimization and Applications (COAP)*, 1-33, 2024.
8. G. Lauga, E. Riccietti, N. Pustelnik & P. Gonçalves, IML FISTA: A Multilevel Framework for Inexact and Inertial Forward-Backward. Application to Image Restoration, *SIAM Journal on Imaging Sciences (SIIMS)*, 2024.
9. A. Gonon, N. Brisebarre, R. Gribonval & E. Riccietti, Approximation speed of quantized vs. unquantized ReLU neural networks and beyond, *IEEE Transactions on Information Theory*, 2023.
10. L. Zheng, E. Riccietti & R. Gribonval, Efficient Identification of Butterfly Sparse Matrix Factorizations, *SIAM Journal on Mathematics of Data Science*, 2023.
11. QT. Le, E. Riccietti & R. Gribonval, Spurious Valleys, NP-hardness, and Tractability of Sparse Matrix Factorization With Fixed Support, *SIAM Journal on Matrix Analysis and Applications*, 2023.

12. A.L. Custodio, Y. Diouane, R. Garmanjani & E. Riccietti, Worst-case complexity bounds of directional direct-search methods for multiobjective optimization, *Journal of Optimization Theory and Applications*, 188(1):1-21, 2020.
13. H. Calandra, S. Gratton, E. Riccietti & X. Vasseur, On iterative solution of the extended normal equations, *SIAM Journal on Matrix Analysis and Applications*, 41(4):1571-1589, 2020.
14. H. Calandra, S. Gratton, E. Riccietti & X. Vasseur, On a multilevel Levenberg-Marquardt method for the training of artificial neural networks and its application to the solution of partial differential equations, *Optimization Methods and Software*, 2020.
15. H. Calandra, S. Gratton, E. Riccietti & X. Vasseur, On high-order multilevel optimization strategies, *SIAM Journal on Optimization*, 31(1):307-330, 2020.
16. S. Bellavia, M. Donatelli & E. Riccietti, An inexact non stationary Tikhonov procedure for large-scale nonlinear ill-posed problems, *Inverse Problems*, 36(9), 2020.
17. S. Bellavia, S. Gratton & E. Riccietti, A Levenberg-Marquardt method for large nonlinear least-squares problems with noisy functions and gradients, *Numerische Mathematik*, 140(3):791-825, Springer, 2018.
18. S. Bellavia & E. Riccietti, On an elliptical trust-region procedure for ill-posed nonlinear least squares problems, *Journal of Optimization Theory and Applications*, 158(3):824-859, 2018.
19. E. Riccietti, S. Bellavia & S. Sello, Sequential Linear Programming and Particle Swarm Optimization for the optimization of energy districts, *Engineering Optimization*, pages 1-17, Taylor & Francis, 2018.
20. E. Riccietti, J. Bellucci, M. Checcucci, M. Marconcini & A. Arnone, Support Vector Machine classification applied to the parametric design of centrifugal pumps, *Engineering Optimization*, pages 1-21, Taylor & Francis, 2017.
21. S. Bellavia, B. Morini & E. Riccietti, On an adaptive regularization for ill-posed nonlinear systems and its trust-region implementation, *Computational Optimization and Applications*, 64(1):1-30, Springer, 2016.

International conferences with proceedings.....

1. E. Desainte-Mareville, M. Foare, P. Gonçalves, N. Pustelnik, E. Riccietti, Multiresolution Adaptive Block-Coordinate Forward-Backward for Image Reconstruction, *EUSIPCO 2026*
2. A. Gonon, N. Brisebarre, E. Riccietti & R. Gribonval, A rescaling-invariant Lipschitz bound based on path-metrics for modern ReLU network parameterizations, *ICML 2025*
3. G. Lauga, A. Repetti, E. Riccietti, N. Pustelnik, P. Gonçalves & Y. Wiaux, A multilevel framework for accelerating uSARA in radio-interferometric imaging, *EUSIPCO 2024*
4. A. Gonon, N. Brisebarre, E. Riccietti & R. Gribonval, A path-norm toolkit for modern networks: consequences, promises and challenges, *ICLR spotlight 2024*
5. Q.T. Le, E. Riccietti & R. Gribonval, Does a sparse ReLU network training problem always admit an optimum?, *NeurIPS 2023*.
6. G. Lauga, E. Riccietti, N. Pustelnik & P. Gonçalves, Multilevel FISTA for Image Restoration, *ICASSP*, 2023.
7. L. Zheng, G. Puy, E. Riccietti, P. Pérez & R. Gribonval, Self-supervised learning with rotation-invariant kernels, *ICLR 2023*.
8. Q.T. Le, L. Zheng, E. Riccietti & R. Gribonval, Fast Learning of Fast Transforms, with Guarantees in *ICASSP 2022*.
9. E. Riccietti, S. Bellavia & S. Sello, Numerical Methods for Optimization Problems Arising in Energetic Districts in *Progress in Industrial Mathematics at ECMI 2016*.

National conferences.....

1. G. Lauga, E. Riccietti, L. Briceño-Arias, N. Pustelnik & P. Gonçalves, Une équivalence entre algorithmes multiniveaux et algorithmes de descente par blocs, *GRETSI 2025*
2. R. Gribonval & E. Riccietti, Une brève histoire de la parcimonie: du traitement de signal à l'apprentissage profond, *GRETSI 2025*

3. N. Laurent, E. Riccietti, J. Tachella & N. Pustelnik, Algorithme multiniveau hybride pour la restauration d'images, GRETSI 2025
4. M. Chaumette, R. Gribonval & E. Riccietti, CROQuant: Complex Rank-One Quantization Algorithm, GRETSI 2025
5. R. Gribonval, T. Mary & E. Riccietti, Scaling is all you need: quantization of butterfly matrix products via optimal rank-one quantization, GRETSI 2023.
6. L. Zheng, G. Puy, E. Riccietti, Perez. P. & R. Gribonval, Factorisation butterfly d'une matrice permuté par partitionnement spectral alterné, GRETSI 2023.
7. G. Lauga, E. Riccietti, N. Pustelnik & P. Gonçalves, Méthodes multi-niveaux pour la restauration d'images hyperspectrales, GRETSI 2023.
8. E. Riccietti, G. Lauga, N. Pustelnik & P. Gonçalves, Méthodes proximales multi-niveaux pour la restauration d'images, GRETSI 2022.

Preprints

1. N. Brisebarre, G. Carrino, T. Mary & E. Riccietti, Mixed precision Newton's method for optimization, 2026.
2. M. Chaumette, R. Gribonval & E. Riccietti, CROQuant: Complex Rank-One Quantization Algorithm, with Application to Butterfly Factorizations, 2026.
3. G. Lauga, E. Riccietti, N. Pustelnik, P. Gonçalves & L. Briceño-Arias, A flexible block-coordinate forward-backward algorithm for non-smooth and non-convex optimization, 2025.
4. R. Gribonval, T. Mary & E. Riccietti, Optimal quantization of rank-one matrices in floating-point arithmetic-with applications to butterfly factorizations, 2023.

Thesis

1. Numerical methods for optimization problems: an application to energetic districts - Master thesis, 2014.
2. Levenberg-Marquardt methods for the solution of noisy nonlinear least squares problems - PhD thesis, 2018.