Maxime Ferreira Da Costa

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Research Interests

Theoretical and algorithmic foundations of data science, structured signal processing, and inverse problems; focussing on issues at the intersection of information theory, statistics, harmonic analysis, and optimization; with applications in sensing, imaging sciences, telecommunications, and networks. Current research topics include:

Physical Layer Security: Exploitation of latent structure in the design of novel wireless transmission protocols protecting both the data and the physical parameters in wireless communication from eavesdropping attempts.

Extremization in the Bandlimit: Research on the harmonic approximation theory of function of bounded variations with implications in controlling the spectral conditioning of measurement operators of physical systems.

Sparsity over the Continuum: Theoretical study of efficient algorithms to solve sparse inverse problems over the set of Radon measures, with application to sensing and imaging systems, and telecommunication.

Academic Employments

Université Paris–Saclay | CentraleSupélec, Gif-sur-Yvette, France

- Maître de Conférences in the Mathematics of Information — Oct. 2022 – Present
  Tenured Assistant / Associate Professor

University of Southern California, Los Angeles, CA, United States

- Post-Doctoral Research Associate — Jan. 2021 – Jul. 2022

Carnegie Mellon University, Pittsburgh, PA, United States

- Post-Doctoral Research Associate — Oct. 2018 – Dec. 2020

Education

Imperial College London, London, United Kingdom

- Ph.D. in Electrical Engineering — 2014 – 2018
  Dissertation: "A Total Variation Approach to Sampling and Sparse Reconstruction from Fourier Measurements"

- M.Sc. in Electrical Engineering — 2011 – 2012
  Major in Signal Processing and Communications

Université Paris–Saclay | CentraleSupélec, Gif-sur-Yvette, France

- Diplôme d'Ingénieur (M.Sc.) — 2009 – 2012
  Major in Applied Mathematics

Lycée Charlemagne, Paris, France

- Classes Préparatoires aux Grandes Écoles (MPSI–MP*) — 2007 – 2009
  Undergraduate preparatory classes to nationwide examinations (Mathematics–Physics)

Industry Employments

Blackrock | eFront, Paris, France

- Financial Software Consultant   Oct. 2012 – Sept. 2014

Short-Term Appointments

Colorado School of Mines, Golden, CO, United States

- Visiting Researcher   Sep. 2017 – Nov. 2017

Huawei Technologies, Boulogne-Billancourt, France

- Visiting Researcher   Jul. 2015 – Sep. 2015

Nokia Bell Labs, Nozay, France

- Network and Software Engineering Intern   Jun. 2011 – Sep. 2011

Honors & Awards

- Best Presentation Award at JWOC 2023 (student: Hassan Mohamad)   2023
  Télécom Paris, Institut Polytechnique de Paris, Palaiseau, France

- Travel Grant for the 2019 February Fourier Talks (FFT)   2019
  University of Maryland, University Park, MD, United States

- **Laureate of the DIM Math Innov Post-Doctoral Fellowship**   2018
  Institut Henri Poincaré, Paris, France

- **Finalist for the Jack Keil Wolf IEEE ISIT Student Paper Award**   2018
  the IEEE Information Theory Society

- EPSRC Doctoral Training Award   2014
  the British Engineering and Physical Sciences Research Council

Research Supervision

Ph.D. Students

- Trong Duy Tran, co-advised with Salah Eddine Elayoubi   starting Sep. 2024
  France Excellence scholarship, the French Embassy in Vietnam

- Santos Michelena, co-advised with José Picheral   started Feb. 2024

- Joseph Gabet, co-advised with Charles Soussen   started Jan. 2024

Research Grants & Industrial Projects

- Agence de l'Innovation de Défense (AID)   2023
  Lead Principal Investigator – French Defense Research Agency

- CIFRE program with IUMTEK   2023
  Lead Principal Investigator – Industrial Partnership

- USC + Amazon Center on Secure and Trusted Machine Learning   2022
  Co-Principal Investigator

Teaching

Lecturer, CentraleSupélec | Université Paris–Saclay, Gif-sur-Yvette, France

- Sampling Theory and Compressed Sensing
Postgraduate Course   Fall 2023

- Signal Processing
Undergraduate Course   Spring 2023–2024

- Introduction to Data Science
Undergraduate Projects   Fall 2022–2023

Lecturer, University of Southern California, Los Angeles, CA, United States

- Random Processes
Postgraduate Course   Fall 2021

Teaching Assistant, Imperial College London, London, United Kingdom

- Topics in Large Dimension Data Processing
Postgraduate Course   Fall 2014 – Fall 2017

- Coding Theory
Postgraduate Course   Spring 2015 – Spring 2018

- Introduction to Python
Undergraduate Projects   Fall 2014 – Fall 2015

Publications

Preprints

[Z1] M. Ferreira Da Costa, "The condition number of weighted non-harmonic Fourier matrices with applications to super-resolution", *hal-04261330*, 2023, preprint.

[Z2] M. Ferreira Da Costa, J. Li, and U. Mitra, "Guaranteed private communication with secret block structure", *arXiv: 2309.09977*, 2023, preprint.

Peer-Reviewed Journals and Magazines

[J1] M. Ferreira Da Costa and Y. Chi, "Local geometry of nonconvex spike deconvolution from low-pass measurements", *IEEE Journal on Selected Areas in Information Theory*, vol. 4, pp. 1–15, 2023.

[J2] X. Shi, P. Sadeghi, N. Lobandi, *et al.*, "Novel, accurate pathogen sensors for fast detection of SARS-CoV-2 in the aerosol in seconds for a breathalyzer platform", *Biosensors and Bioelectronics: X*, vol. 14, p. 100 369, Sep. 1, 2023.

[J3] J. Li, M. Ferreira Da Costa, and U. Mitra, "Joint localization and orientation estimation in millimeter-wave MIMO OFDM systems via atomic norm minimization", *IEEE Transactions on Signal Processing*, pp. 1–12, 2022.

[J4] M. Ferreira Da Costa and Y. Chi, "Compressed super-resolution of positive sources", *IEEE Signal Processing Letters*, vol. 28, pp. 56–60, 2021.

[J5] Y. Chi and M. Ferreira Da Costa, "Harnessing sparsity over the continuum: Atomic norm minimization for superresolution", *IEEE Signal Processing Magazine*, vol. 37, no. 2, pp. 39–57, 2020.

[J6] M. Ferreira Da Costa and Y. Chi, "On the stable resolution limit of total variation regularization for spike deconvolution", *IEEE Transactions on Information Theory*, vol. 66, no. 11, pp. 7237–7252, 2020.

Conference Preprints

[Y1] T. D. Tran, M. Ferreira Da Costa, and L. T. Nguyen, "Physical layer location privacy in SIMO communication using fake paths injection", *arXiv:2402.01198*, Feb. 2, 2024, preprint.

Peer-Reviewed Conference and Workshops Proceedings

[C1] M. Ferreira Da Costa, S. E. Elayoubi, and W. Hajji, "Goal-oriented communications for distributed sensing: A joint scheduling and estimation approach", in *IEEE 99th Vehicular Technology Conference (VTC 2024)*, 2024, accepted.

[C2] J. Gabet and M. Ferreira Da Costa, "Preconditioned gradient descent for sketched mixture learning", in *2024 IEEE International Symposium on Information Theory (ISIT)*, 2024, accepted.

[C3] M. Kalra, M. Ferreira Da Costa, and K. Lee, "Small-noise sensitivity analysis of locating pulses in the presence of adversarial perturbation", in *2024 IEEE Sensor Array and Multichannel Signal Processing Workshop (SAM)*, 2024, accepted.

[C4] M. Ferreira Da Costa, "Second-order Beurling approximations and super-resolution from bandlimited functions", in *2023 International Conference on Sampling Theory and Applications (SampTA)*, 2023, pp. 1–5.

[C5] M. Ferreira Da Costa and U. Mitra, "A framework for private communication with secret block structure", in *2022 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, 2022, pp. 5657–5661.

[C6] M. Ferreira Da Costa and U. Mitra, "On the stability of super-resolution and a Beurling–Selberg type extremal problem", in *2022 IEEE International Symposium on Information Theory (ISIT)*, 2022, pp. 1737–1742.

[C7] J. Li, M. Ferreira Da Costa, and U. Mitra, "Atomic norm based localization and orientation estimation for millimeter-wave MIMO OFDM systems", in *2022 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, 2022, pp. 5363–5367.

[C8] M. Ferreira Da Costa and Y. Chi, "Support stability of spike deconvolution via total variation minimization", in *2020 54th Annual Conference on Information Sciences and Systems (CISS)*, 2020, pp. 1–6.

[C9] M. Ferreira Da Costa and Y. Chi, "Self-calibrated super resolution", in *2019 53rd Asilomar Conference on Signals, Systems, and Computers*, 2019, pp. 230–234.

[C10] M. Ferreira Da Costa and W. Dai, "A tight converse to the spectral resolution limit via convex programming", in *2018 IEEE International Symposium on Information Theory (ISIT)*, 2018, pp. 901–905, **finalist for the IEEE ISIT Jack Keil Wolf Award**.

[C11] M. Ferreira Da Costa and W. Dai, "Low dimensional atomic norm representations in line spectral estimation", in *2017 IEEE International Symposium on Information Theory (ISIT)*, 2017, pp. 226–230.

[C12] M. Ferreira Da Costa and W. Dai, "Sampling patterns for off-the-grid spectral estimation", in *2017 51st Asilomar Conference on Signals, Systems, and Computers*, 2017, pp. 318–322.

[C13] M. Ferreira Da Costa and W. Dai, "Achieving super-resolution in multi-rate sampling systems via efficient semidefinite programming", in *2016 IEEE Information Theory Workshop (ITW)*, 2016, pp. 424–428.

Peer-Reviewed Conference and Workshops Abstracts

[A1] J. Gabet and M. Ferreira Da Costa, "Adaptive preconditioned gradient descent for sketched mixture learning", in *5th Junior Conference on Wireless and Optical Communications (JWOC)*, 2023.

[A2] H. Mohamad and M. Ferreira Da Costa, "Inverse optimal transport regularized in the Fourier domain", in *5th Junior Conference on Wireless and Optical Communications (JWOC)*, 2023, **best presentation award**.

[A3] M. Ferreira Da Costa and W. Dai, "On the spectral resolution limit of TV-regularization", in *6th IMA Conference on Numerical Linear Algebra and Optimization*, 2018.

[A4] M. Ferreira Da Costa and W. Dai, "A guaranteed poly-logarithmic time relaxation for the line spectral estimation problem", in *2017 Signal Processing with Adaptive Sparse Structured Representations Workshop (SPARS)*, 2017, **presented in plenary session**.

Colloquia, Seminars, and Invited Talks

[P1] "Confluent weighted Ingham inequalities with signal processing applications", Séminaire d'Analyse, Institut Mathématiques de Bordeaux, Bordeaux, France, May 2024.

[P2] "Higher-order Beurling-Selberg approximations and the stability of super-resolution", the Paris–Saclay Signal Seminar (S3), Université Paris–Saclay, Gif-sur-Yvette, France, Apr. 2024.

[P3]   "Goal-oriented communications for distributed sensing of Gaussian sources", Goal Oriented and Semantic Communications Colloquium, INRIA, Paris, France, Nov. 2023.

[P4]   "Higher-order Beurling-Selberg approximations and the stability of super-resolution", 11th Applied Inverse Problems Conference (AIP 2023), Göttingen, Germany, Sep. 2023.

[P5]   "Local geometry of spike deconvolution: A resolution–convergence tradeoff", Workshop on off-the-grid and continuous optimization, Institut Henri Poincaré (IHP), Paris, France, Nov. 2023.

[P6]   "Physical layer security with structural priors", MIND seminar, INRIA Saclay, Palaiseau, France, Nov. 2023.

[P7]   "Berling–Selberg extremization and the Rayleigh limit", the Ohio State University, OH, USA, Nov. 2022.

[P8]   "Latent privacy via a secret block structure", CentraleSupélec, Université Paris-Saclay, Gif-sur-Yvette, France, May 2022.

[P9]   "Latent privacy via a secret block structure", Eurecom, Sophia–Antipolis, France, May 2022.

[P10]   "Latent privacy via a secret block structure", Applied Mathematics Colloquium, UCLA, Los Angeles, CA, USA, Apr. 2022.

[P11]   "Resolution limits of the point-source deconvolution problem", Machine Learning Colloquium, ENS Lyon & INRIA Lyon, France, Jun. 2022.

[P12]   "Self-calibrated super resolution using atomic norm minimization", Information Theory Colloquium, University of Southern California, Los Angeles, CA, USA, Sep. 2020.

[P13]   "Spectral resolution: Stability and robustness", Applied Mathematics Colloquium, Carnegie Mellon University, Pittsburgh, PA, USA, Jul. 2019.

[P14]   "Super-resolution without calibration", 2019 February Fourier Talks (FFT), University of Maryland, College Park, MD, USA, Feb. 2019.

[P15]   "Spectral resolution: Stability and robustness", 6th IMA Conference on Numerical Linear Algebra and Optimization, Birmingham, UK, Jun. 2018.

[P16]   "Spectral resolution: Stability and robustness", Signal Processing Colloquium, Colorado School of Mines, CO, USA, Jun. 2018.

[P17]   "Compressed sensing on continuous spaces", Mathematics of Information Colloquium, the Alan Turing Institute, London, UK, Feb. 2017.

Professional Services

Review Activities

- Reviewer for Grant Panels

  - Agence Nationale de la Recherche (ANR): Foundations of digital technology.

- Reviewer for Peer-Reviewed Journals

  - IEEE Journals: Transactions on Information Theory, Transactions on Signal Processing, Signal Processing Letters, Transactions on Image Processing;
  - the SIAM Journal on Imaging Science;
  - the IMA Journal on Information and Inference;
  - Elsevier, EURASIP, Signal Processing;
  - Frontiers in Signal Processing (Signal Processing Theory section).

- Reviewer for Peer-Reviewed Conferences, including: the International Conference on Machine Learning (ICML), the Conference on Neural Information Processing Systems (NeurIPS), the International Conference on Learning Representations (ICLR), the IEEE International Symposium on Information Theory (ISIT), the IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP).

Conference, Workshop, and Symposium Organization Roles

- Co-Chair, the 2024 Junior Conference on Wireless and Optical Communication (JWOC 2024), Université Paris–Saclay, Gif-sur-Yvette, France.

- Co-Chair, the 2023 Junior Conference on Wireless and Optical Communication (JWOC 2023), Institut Polytechnique de Paris (IP Paris), Palaiseau, France.

- Session Chair, the 2021 IEEE Conference on Acoustics, Speech and Signal Processing (ICASSP 2021), Toronto, ON, Canada.

- Assistant Organizer, the 2020 NSF Workshop on Predictive Intelligence for Pandemic Prevention (PIPP 2020), online event.

- Assistant Organizer, the London Workshop on Sparse Signal Processing, 2016 and 2018 editions, London, UK.

- Student Volunteering, the 2015 IEEE International Conference on Communications (ICC 2015), London, UK.