Charles-Gérard LUCAS

French citizen, born on October 6^{th} 1995

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Education

2020 - 2023 **PhD Thesis in Physics**
École Normale Supérieure de Lyon, Lyon, France.
Title: Multivariate self-similarity: estimation of the self-similarity exponents, bootstrap test for the equality of exponents and applications
Supervisors: Patrice Abry, Herwig Wendt.

2019 - 2020 **Master 2 Optimisation**
Université Paris-Saclay, Palaiseau, France.
Equivalent to a Master of Science degree in Applied Mathematics.
Fields: calculus of variations, optimal transport, game theory.

2018 - 2019 **Master 2 SISEA**
Université de Rennes 1, Rennes, France.
Equivalent to a Master of Science degree in Image Processing.
Fields: computer vision, statistics, machine learning, medical imaging.

2016 - 2019 **Diplôme d'Ingénieur Généraliste**
IMT Atlantique, Brest, France.
Equivalent to Master of Science degree in Telecommunication Engineering.
Fields: signal processing, optics, electromagnetism, programming.
Course: research methodology course, specialization in image processing, study semester at Polytechnic University of Valencia, Spain.

2016 - 2018 **Licence & Master 1 Mathématiques Fondamentales**
Université de Bretagne Occidentale, Brest, France.
Equivalent to a Bachelor of Science degree in Fundamental Mathematics.
Fields: functional analysis, probability, abstract algebra.

2013 - 2016 **Classe Préparatoire MP**
Lycée Jeanne d'Albret, Saint-Germain-en-Laye, France.
Intensive preparation for the national competitive entrance examination to leading French Engineering Schools, specializing in Mathematics and Physics.

Research experience

2023 - now	**Post-doctoral research**, *Mathematics Dept., SDSU*, San Diego, USA.
Supervisor	Jérôme Gilles.
Activity	*Generalization of empirical wavelet transforms from any mother wavelet using diffeomorphisms.*
Keywords	Image processing, empirical wavelet, diffeormophism.

2020	**Internship** (5 months), *Laboratoire de Physique, ENS de Lyon*, Lyon, France.
Supervisor	Nelly Pustelnik, Barbara Pascal, Patrice Abry.
Title	*Contour detection using Mumford-Shah.*
Keywords	Image processing, inverse problem, proximal algorithms, risk estimator.

2019	**Internship** (6 months), *CosmoStat, CEA Saclay*, Gif-sur-Yvette, France.
Supervisor	Morgan Schmitz, Jean-Luc Starck.
Title	*Point Spread Function modeling in astronomy.*
Keywords	Image processing, inverse problem, proximal algorithms, wavelets.

2018 - 2019	**Project** (6 months), *LaTIM, IMT Atlantique*, Brest, France.
Supervisor	Chafiaa Hamitouche.
Title	*Analysis of morpho-functional signatures obtained using dual quaternions on a group of patients who are candidates for a knee arthroplasty.*
Keywords	Morpho-functional modeling, dual quaternions, Lie algebra, dynamic time warping.

Publications & communications

Preprint

1. Charles-Gérard Lucas and Jérôme Gilles. Multidimesional empirical wavelet transform. *arXiv preprint arXiv:2405.06188*, 2024

Journal papers

3. Charles-Gérard Lucas, Gustavo Didier, Herwig Wendt, and Patrice Abry. Multivariate selfsimilarity: Multiscale eigenstructures for selfsimilarity parameter estimation. *IEEE Transactions on Signal Processing*, 2024

2. Charles-Gérard Lucas, Barbara Pascal, Nelly Pustelnik, and Patrice Abry. Hyperparameter selection for Discrete Mumford–Shah. *Signal, Image and Video Processing*, 17(5):1897–1904, 2023

1. Patrice Abry, Nelly Pustelnik, Stéphane Roux, Pablo Jensen, Patrick Flandrin, Rémi Gribonval, Charles-Gérard Lucas, Éric Guichard, Pierre Borgnat, and Nicolas Garnier. Spatial and temporal regularization to estimate COVID-19 reproduction number R(t): Promoting piecewise smoothness via convex optimization. *Plos one*, 15(8):e0237901, 2020

Conference papers

6. Charles-Gérard Lucas, Patrice Abry, Herwig Wendt, and Gustavo Didier. Epileptic seizure prediction from eigen-wavelet multivariate selfsimilarity analysis of multi-channel EEG signals. In *2023 31th European Signal Processing Conference (EUSIPCO)*. IEEE, 2023

5. Charles-Gérard Lucas, Patrice Abry, Herwig Wendt, Gustavo Didier, and Oliver Orejola. Bootstrap based test for the unimodality of estimated Hurst exponents. performance assessment in a high-dimensional analysis setting. In *XXVIVème Colloque Francophone de Traitement du Signal et des Images (GRETSI 2023)*, 2023

4. Charles-Gérard Lucas, Herwig Wendt, Patrice Abry, and Gustavo Didier. Multivariate time-scale bootstrap for testing the equality of selfsimilarity parameters. In *XXVIIIème Colloque Francophone de Traitement du Signal et des Images (GRETSI 2022)*, 2022

3. Charles-Gérard Lucas, Patrice Abry, Herwig Wendt, and Gustavo Didier. Drowsiness detection from polysomnographic data using multivariate selfsimilarity and eigen-wavelet analysis. In *2022 44th Annual International Conference of the IEEE Engineering in Medicine & Biology Society (EMBC)*, pages 2949–2952. IEEE, 2022

2. Charles-Gérard Lucas, Patrice Abry, Herwig Wendt, and Gustavo Didier. Counting the number of different scaling exponents in multivariate scale-free dynamics: Clustering by bootstrap in the wavelet domain. In *ICASSP 2022-2022 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, pages 5513–5517. IEEE, 2022

1. Charles-Gérard Lucas, Patrice Abry, Herwig Wendt, and Gustavo Didier. Bootstrap for testing the equality of selfsimilarity exponents across multivariate time series. In *2021 29th European Signal Processing Conference (EUSIPCO)*, pages 1960–1964. IEEE, 2021

Seminars

2. FracText colloquium: Text identification and multifractal analysis
   Identification of the original or translated nature of a text
   Créteil, France, September 29^{th}-30^{th} 2022

1. Journées du GDR AMA - CNRS: Self-similarity and multifractal analysis
   Clustering self-similarity exponents of multivariate time series by a wavelet-domain bootstrap
   Porquerolles, France, September 27^{th}-30^{th} 2021

Softwares

2. OFBM Tools (`https://github.com/charlesglucas/ofbm_tools`)
   Matlab toolbox for operator fractional Brownian motion (ofBm) analysis. Estimation and counting of scaling parameters of multivariate self-similar signals.

1. SUGAR D-MS (`https://github.com/charlesglucas/sugar_dms`)
   Matlab toolbox for joint denoising and contour detection of images. Minimization of the Discrete Mumford-Shah functional with automatic selection of hyperparameters.

Teaching experience

École Normale Supérieure (ENS) de Lyon

Master of Complex Systems

- Complex networks - Second year (12h) 2021 - 2022, 2022 - 2023
  Practical exercices and numerical implementation (Python)
  Fundamentals of Network Science, e.g., classic random models, centralities, small-world phenomenon ; Advances topics, e.g., dynamic networks, graph algorithmic, community detection, machine learning on graphs.

École supérieure de chimie, physique, électronique de Lyon (CPE Lyon)

Master of Chemical Engineering

- Random Signal Processing - First year (16h) 2022 - 2023
  *Practical exercices and numerical implementation (*Matlab*)*
  Random signals, spectral estimation, quadratic detection, linear prediction.

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Bachelor of Mathematics

- Introduction to numerical analysis - Second year (12h) 2021 - 2022, 2022 - 2023
  Practical exercices, numerical implementation (Python) and written examinations
  Polynomial interpolation, quadrature method, root-finding algorithms, numerical methods for differential equations.

- Geometric algebra - Second year (40h) 2021 - 2022
  Practical exercices and written examinations
  Inner product, orthogonality, orthogonal projection on finite-dimensional subspaces, affine hyperplane in Euclidean spaces, vectorial isometry in Euclidean spaces, vectorial endomorphism in Euclidean spaces.

- Linear and bilinear algebra, matrix analysis - Third year (12h) 2021 - 2022
  Practical exercices
  Quadratic forms, endomorphism in Euclidean space, endomorphism in Hermitian space, linear systems.

- Fundamentals of mathematics - First year (24h) 2020 - 2021
  Colles (oral examinations)
  Complex numbers, sequences and limits, real-valued functions of a real variable, limits and continuity, derivation of real-valued functions, integer arithmetic, polynomials.

- Basic mathematical techniques - First year (40h) 2020 - 2021
  Lectures, practical exercices and written examinations
  Riemann integration, first and second order linear differential equations, complex numbers, vector spaces, geometry in the plane and in space.

Administrative experience

4. PhD student seminars in Laboratoire de Physique, ENS de Lyon
   Co-organizer with Thomas Basset
   Regular research talks from the PhD students in Physics.
   November 2022 - September 2023

3. PhD student reprensentative of Laboratoire de Physique, ENS de Lyon
   Elected
   October 2022 - September 2023

2. Helper for the organization of Conference on Complex Systems (CCS)
   Helper in the organization team
   International conference in Lyon, France. Organized by Pierre Borgnat and Márton Karsai.
   October 25^{th}-29^{th} 2021

1. PhD Day of Laboratoire de Physique, ENS de Lyon
   Co-organizer with Thomas Basset
   Day of seminars. Research talks of first and second year PhD students in Physics.
   June 22^{nd} 2022

Skills

Computing	MATLAB, Python, LaTeX
Graphics editor	Inkscape
Languages	French (native), English (advanced), Spanish (advanced), Arabic (beginner)