Bruno Loureiro

Personal Information

Dr. Bruno Loureiro
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Employment history

07.2020–present **École Polytechnique Fédérale de Lausanne**, *Postdoctoral researcher*.
Advisor: Prof. Florent Krzakala

07.2018–08.2020 **Institut de Physique Théorique**, *Postdoctoral researcher*.
Advisor: Prof. Lenka Zdeborová

04.2018–08.2018 **BTG Pactual UK**, *Data Science Intern*.

01.2011–06.2011 **University of Paris 7 - Department of Physics**, *Assistant librarian*.

Education

10.2014–06.2018 **PhD in Physics**, *University of Cambridge*.
Title: *Disorder in holographic field theories: inhomogeneous geometries, momentum relaxation and SYK models*
Advisor: Prof. A.M. García-García

10.2013–07.2014 **MASt in Applied Mathematics**, *University of Cambridge*, *Merit*.
Master Thesis: *Integrability and Self-Duality*,
Advisor: Dr. Maciej Dunajski

06.2012–07.2012 **Internship**, *Laboratoire de physique nucléaire et des hautes énergies*.
Project: *Non-gaussianities in the CMB*
Advisor: Dr. Pierre Astier

09.2011–08.2013 **BSc Mathematics and Physics**, *King's College London*, *First Class Honours*.
BSc Thesis: *Non-gaussianities in the CMB*
Advisor: Prof. Eugene Lim

09.2010–08.2011 **BSc Physics**, *University of Paris 7 – Denis Diderot*, *Result – 16.674/20*.

08.2008–04.2010 **Internship**, *Fundaçao Oswaldo Cruz*.
Project: *Characterization of the Oligopeptidase B2 of Leishmania Amazonensis*
Advisor: Prof. Herbert Guedes

Teaching Experience

09.2021–present **Lecturer**, École Polytechnique Fédérale de Lausanne.
Subject: Statistical physics of computation. Responsible for exercise sessions. Hours in classroom: 28h.

02.2021–06.2021 **Lecturer**, École Polytechnique Fédérale de Lausanne.
Subject: Statistical Physics For Optimization and Learning. Responsible for exercise sessions.
Hours in classroom: 28h.

01.2017–06.2017 **Supervisor**, *King's College*, University of Cambridge.
Subject: Mathematical Biology, 2-to-1 supervisions for 1st year biology students.
Hours in classroom: 24h

10.2014–06.2016 **Supervisor**, *King's College*, University of Cambridge.
Subject: Mathematical Methods 1. 2-to-1 supervisions for Part 1A (1st year) NatSci students.
Hours in classroom: 84h

Supervising Experience

02.2021–07.2021 **MSc project supervisor**, *IdePHICS*, EPFL.
Co-supervision of two master projects on Statistical Physics of Learning at IdePHICS.

02.2021–current **Visiting PhD student**, *IdePHICS*, EPFL.
Co-supervision of a visiting PhD student on Statistical Physics of Learning at IdePHICS.

09.2021–current **MSc project supervisor**, *IdePHICS*, EPFL.
Co-supervision of one master projects on Statistical Physics of Learning at IdePHICS.

09.2021–current **PhD project**, *IdePHICS*, EPFL.
Co-supervision of three PhD projects at the IdePHICS lab.

Scientific Reviewing

02.2022–present **IOP Machine Learning: Science and Technology**, *Referee*.

02.2022–present **IEEE Transactions on Neural Networks and Learning Systems**, *Referee*.

12.2021–present **International Conference on Machine Learning (ICML)**, *Referee*.

09.2021–present **Journal of Machine Learning Research (JMLR)**, *Referee*.

08.2021–present **Physica A: Statistical Mechanics and its Applications**, *Referee*.

06.2021–present **International Conference on Learning Representations (ICLR)**, *Referee*.

04.2021–present **IEEE Transactions on Information Theory**, *Referee*.

04.2021–present **Conference on Neural Information Processing Systems (NeurIPS)**, *Referee*.

03.2021 **Science and Engineering of Deep Learning Workshop**, *Referee*.

07.2020–present **Journal of Statistical Mechanics: Theory and Experiment**, *Referee*.

Scientific Organisation

03.2022 (to come) **AI & Physics track, Applied Machine Learning Days (AMLD)**, *Organiser*.

11.2021–present **Foundations of Learning and AI Research (FLAIR), Junior meetings**, *Organiser*.

06.2021–present **Theory of Neural Nets Seminar**, *Organiser*.

09.2020–present **SPOC+IdePHICS+PCLS Joint group meeting**, *Organiser*.

Research interests

I am interested in theoretical problems in high-dimensional Statistics which are motivated by practical challenges in Statistical Inference, Signal Processing and Machine Learning, e.g. low-rank matrix factorisation, phase retrieval and learning in neural networks, to cite a few. My approach to these problems leverage techniques originally developed in the context of Statistical Physics and Disordered Systems to address questions of interest in these fields. As an example, two questions often motivating

my works are: what is the typical algorithmic complexity of an inference task? How many samples are needed for a neural network to learn a target rule?

Publications

Note: asterisk $*$ denotes first authors / equal contribution.

Phase diagram of Stochastic Gradient Descent in high-dimensional two-layer neural networks, R Veiga*, L Stephan*, B Loureiro, F Krzakala, L Zdeborová arXiv: 2202.00293 [stat.ML].

Fluctuations, Bias, Variance & Ensemble of Learners: Exact Asymptotics for Convex Losses in High-Dimension, B Loureiro*, C Gerbelot*, M Refinetti, G Sicuro, F Krzakala, arXiv: 2201.13383 [stat.ML].

Error Rates for Kernel Classification under Source and Capacity Conditions, H Cui*, B Loureiro, F Krzakala, L Zdeborová, arXiv: 2201.12655 [cs.ML].

Bayesian Inference with Nonlinear Generative Models: Comments on Secure Learning, A Bereyhi*, B Loureiro, F Krzakala, R R Müller, H Schulz-Baldes, arXiv: 2201.09986 [cs.IT].

Learning Gaussian Mixtures with Generalised Linear Models: Precise Asymptotics in High-dimensions, B Loureiro*, G Sicuro*, C Gerbelot*, A Pacco, F Krzakala, L Zdeborová, NeurIPS 2021 (spotlight: top 3%).

Generalization Error Rates in Kernel Regression: The Crossover from the Noiseless to Noisy Regime, H Cui*, B Loureiro*, F Krzakala, L Zdeborová, NeurIPS 2021.

Learning curves of generic features maps for realistic datasets with a teacher-student model, B Loureiro*, C Gerbelot*, H Cui, S Goldt, F Krzakala, M Mézard, L Zdeborová, NeurIPS 2021.

The Gaussian equivalence of generative models for learning with shallow neural networks, S Goldt*, B Loureiro*, G Reeves*, F Krzakala, M Mézard, L Zdeborová, MSML 2021.

Phase retrieval in high dimensions: Statistical and computational phase transitions, A Maillard*, B Loureiro, F Krzakala, L Zdeborová, NeuRIPS 2020

Generalisation error in learning with random features and the hidden manifold model, F Gerace*, B Loureiro*, F Krzakala, M Mézard, L Zdeborová, ICML 2020

Exact asymptotics for phase retrieval and compressed sensing with random generative priors, B Aubin*, B Loureiro*, A Baker, F Krzakala, L Zdeborová, MSML 2020

The spiked matrix model with generative priors, B Aubin*, B Loureiro*, A Maillard*, F Krzakala, L Zdeborová, IEEE Transactions on Information Theory

Coherence effects in disordered geometries with a field-theory dual, AM Garcia-Garcia, B Loureiro*, T Andrade*, J. High Energ. Phys. (2018) 2018: 187

Chaotic-Integrable Transition in the Sachdev-Ye-Kitaev Model, AM Garcia-Garcia*, B Loureiro*, A Romero-Bermudez* and T Masaki*, Phys. Rev. Lett. 120, 241603 (2018)

Transport in a gravity dual with a varying gravitational coupling constant, AM Garcia-Garcia, B Loureiro* and A Romero-Bermudez*, Phys. Rev. D 94 086007 (2016)

Marginal and irrelevant disorder in Einstein-Maxwell backgrounds, AM Garcia-Garcia and B Loureiro*, Phys. Rev. D 93 065025 (2016)

Fellowships, Awards and Distinctions

09.2013–08.2017 CAPES/Cambridge Overseas Trust Science Without Borders Scholarship

11.2013 Nikon Prize for the best Physics Project, King's College London

11.2012 Prize for the best performance in Mathematics modules by a Joint Honours student, King's College London

08.2011 Ranked 2/209 in the general rank of the Natural Sciences Department, University of Paris 7 – Denis Diderot

04.2010 Selected among best projects in the Program of Scientific Vocation (PROVOC) FioCruz

Invited Conference Speaker

12.2021 MRS Fall Meeting & Exhibit, Accelerating Materials Characterization, Modeling, and Discovery by Physics-Informed Machine Learning Symposium, Boston

09.2021 Applied Machine Learning Days, AI & Physics track, École Polytechnique Fédérale de Lausanne

09.2021 On Future Synergies for Stochastic and Learning Algorithms, Centre International de Rencontres Mathématiques, Marseille

09.2021 Rigorous Evidence for Information-Computation Trade-offs, Simons Institute for the Theory of Computing, Berkeley University of California

08.2021 IFIP TC7 Conference on System Modelling and Optimization, Generative Regularization Approaches for Inverse Problems minisymposium, Quito

04.2021 IEEE Information Theory Workshop, Statistical Physics and Machine Learning Session

06.2020 Youth in High-dimensions conference, ICTP, Trieste

Peer-reviewed conferences

12.2021 Spotlight "*Learning Gaussian Mixtures with Generalised Linear Models: Precise Asymptotics in High-dimensions*", NeurIPS 2021

12.2021 Poster "*Generalization Error Rates in Kernel Regression: The Crossover from the Noiseless to Noisy Regime*", NeurIPS 2021

12.2021 Poster "*Learning curves of generic features maps for realistic datasets with a teacher-student model*", NeurIPS 2021

11.2021 Talk "*Exactly solvable models for learning with realistic data*", DeepMath 2021

11.2021 Poster "*Learning Gaussian Mixtures with Generalised Linear Models: Precise Asymptotics in High-dimensions*", DeepMath 2021

12.2020 Poster "*Phase retrieval in high dimensions: Statistical and computational phase transitions*", NeurIPS 2020

11.2020 Poster "*Generalisation error in learning with random features and the hidden manifold model*", DeepMath 2020

07.2020 Talk, "*Exact asymptotics for phase retrieval and compressed sensing with random generative priors*, MSML 2020

07.2020 Poster "*Generalisation error in learning with random features and the hidden manifold model*", ICML 2020

12.2019 Poster "*The spiked matrix model with generative priors*", NeurIPS 2019

07.2009 Poster "*Identification and Cellular Localization of the Oligopeptidase B2 of Leishmania Amazonensis*", XXIV International Meeting of the Federation of Experimental Biology (FeSBE).

Invited Seminars

12.2021 Dyogene team, INRIA, Paris

11.2021 Dante team, INRIA & ENS Lyon, Lyon

11.2021 AO/Tau team, INRIA & Université Paris Saclay, Paris

11.2021 DataLearning Working Group, Imperial College, London

06.2021 Quantitative Life Sciences seminar, ICTP, Trieste

05.2021 Seminar Series on Complex Systems, UAM Mexico

04.2021 Statistical Data Science group, École Polytechnique Fédérale de Lausanne

03.2021 Oxford Neurotheory Lab, University of Oxford

03.2021 Mathematics of Data Science group, ETH Zurich

02.2021 Disordered Systems Group, King's College London

12.2020 Équipe Mokaplan, INRIA Paris

02.2020 Escola de Matemática Aplicada (EMAP/FGV), Rio de Janeiro

01.2020 Centre de Mathématiques Appliquées (CMAP), École Polytechnique, Paris

Workshops and visits

06.2021 Workshop "Glassy Systems and Inter-Disciplinary Applications", Institut d'Études Scientifiques de Cargèse, France

10.2019 Workshop on Science of Data Science, ICTP, Trieste

03.2019 Visitor at "Machine Learning for Quantum Many-Body Physics" program, KITP, Santa Barbara

08.2018 Workshop "Statistical Physics and Machine Learning back together", Institut d'Études Scientifiques de Cargèse, France

06.2017 Short Visit, Brazilian Centre for Research in Physics (CBPF)

02.2017 Workshop, "Disorder in Condensed Matter and Black Holes", Lorentz Center, Leiden University

03.2015 Workshop "Holographic Methods for Strongly Coupled Systems", Galileo Galilei Institute for Theoretical Physics

Other participation

12.2021 NeurIPS@Paris, Paris (satellite event)

12.2021 NeurIPS@EPFL, Lausanne (satellite event)

03.2017 School on AdS/CMT Correspondence, ICTP-SAIFR
Short Talk *Disorder in AdS/CMT*

07.2016 Condensed Matter and Beyond, University of Oxford

05.2016 Quantum Information in String Theory and Many-body Systems, Yukawa Institute for Theoretical Physics, Kyoto University

08.2015 Physics by the Lake summer school, Cumberland Lodge

06.2015 Eurostrings, University of Cambridge

02.2013 Tomorrow's Mathematicians Today, University of Greenwhich

07.2011 28th Brazilian Colloquium of Mathematics, IMPA

07.2010 VIII School of the Brazilian Centre for Research in Physics (CBPF)

04.2008 XIII Week of Scientific Vocation, FioCruz

Presented project *Cloning and Characterization of the Oligopeptidase B2 of Leishmania Amazonensis*

Numerical Skills

PYTHON (Intermediate), MATHEMATICA (Intermediate), LaTeX (Advanced).

Languages

English (Fluent), French (Fluent), Italian (Intermediate), Portuguese (Native).

Extra-academic activities

08.2017 **Physics Supervisor**, *Sutton Trust*, Sutton Trust Scholar Program.
The Sutton Trust scholar program has the objective of increasing access to leading universities from state schools with lower than average progression to higher education. Gifted students have the opportunity to experience University level courses and to exchange with researchers.

01.2015–12.2016 **Cambridge University Brazilian Society**, *President*.

01.2008–07.2010 **Physics teacher**, *Pré-vestibular comunitário UniRio*.
This program provided free lessons for disadvantaged students of low-income communities of Rio de Janeiro. The lessons aimed at preparing the students for the public university entry exams.