Hugo Cui

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Profile

About me ——

I am an independent postdoc fellow in applied mathematics in the Center of Mathematical Sciences and Applications (CMSA) at Harvard University. Prior to that, I did my PhD studies in machine learning and physics at EPFL, advised by Lenka Zdeborová. My research lies at the crossroads of statistical physics, machine learning theory and high-dimensional probability, and aims at reaching a theoretical understanding of learning in neural networks.

Languages ——

French (*native*), English (*CEFR C2*), Italian (*CEFR B1*), Spanish (*CEFR B1*), German (*CEFR A1*)

Education

Harvard University — *Cambridge, USA*
Independent postdoctoral researcher at the Center of Mathematical Sciences and Applications (Harvard CMSA) — *2024 –*

EPFL — *Lausanne, Switzerland*
PhD in machine learning theory and statistical physics, advised by Lenka Zdeborová — *2020 – 2024*

ENS Paris — *Paris, France*
Masters in theoretical physics — *2016 – 2020*

- MSc in theoretical physics (international center for fundamental physics), *Highest Honours*
- Bachelor in physics, *Highest Honours*
- Entrance via national competitive examination, ranked 1st/1000+.

Experience

Courant Institute of Mathematical Sciences (NYU) — *New York, USA*
Visiting PhD student, hosted by Eric Vanden-Eijnden — *2023*

Capital Fund Management — *Paris, France*
Risk management Intern — *2020*

Institute of Theoretical Physics (CEA Saclay) — *Paris, France*
Master thesis, with Lenka Zdeborová — *2019*

University of Zurich — *Zurich, Switzerland*
Master internship, theory of quantum topological materials, with Titus Neupert — *2018*

Non profit ——

Innovation Forum — *Lausanne, Switzerland*
Business associate at the Swiss branch. Promotion of start-ups and technological transfer through interviews, conferences. Organization of an accelerator and mentorship program for early stage start-ups. — *2021*

Awards and certifications

EPFL Physics doctoral thesis award, 1st prize	2024
EPFL Best 8% thesis distinction, Physics	2024
G-Research PhD prize in mathematics and data science, EPFL 3rd prize	2024
Recipient of a competitive Harvard CMSA Postdoctoral Fellowship	2024
Famelab (international science communication competition) finalist, representing Switzerland.	2021
Famelab Switzerland national winner	2021

Ranked 1st /1000+ at Ecole Normale Supérieure national entrance exam 2016
Ranked 4th/1000+ at French Ecole Polytechnique national entrance exam 2016
Laureate of two of the French Academy of Science thematic awards (for a bronze medal at the 46th International Chemistry Olympiads and the 2nd prize at the French Chemistry Olympiads) 2014

Certificates ——

- Cambridge Proficiency Certificate CEFR C2
- Swiss Innovation Agency Business Concepts Certificate

List of publications

∗ denotes equal contributions. All full-text versions are accessible from my personal website.

1. *A precise asympotic analysis of learning diffusion models: theory and insights*
   H. Cui, C. Pehlevan, Y. M. Lu
   preprint arXiv:2501.03937

2. *A Random Matrix Theory Perspective on the Spectrum of Learned Features and Asymptotic Generalization Capabilities*
   Y. Dandi, L. Pesce, **H. Cui**, F. Krzakala, Y. M. Lu, B. Loureiro
   preprint arXiv:2410.18938

3. *High-dimensional learning of narrow neural networks*
   H. Cui
   preprint arXiv:240913904

4. *A phase transition between positional and semantic learning in a solvable model of dot-product attention*
   H. Cui, F. Behrens, F. Krzakala, L. Zdeborová
   NeurIPS 2024 **Spotlight** (top 2.1% of submissions).

5. *Asymptotics of feature learning in two-layer networks after one gradient-step*
   H. Cui, L. Pesce, Y. Dandi, F. Krzakala, Y. M. Lu, L. Zdeborová, B. Loureiro
   ICML 2024 **Spotlight** (top 2% of submissions).

6. *Asymptotics of learning with deep structured (random) features*
   D.Schröder, D.Dmitriev, **H.Cui**, B.Loureiro
   ICML 2024.

7. *Analysis of learning a flow-based generative model from limited sample complexity*
   H. Cui, E. Vanden-Eijnden, F. Krzakala, L. Zdeborová
   ICLR 2024

8. *High-dimensional asymptotics of denoising auto-encoders*
   H. Cui, L. Zdeborová
   NeurIPS 2023 **Spotlight** (top 3.1% of submissions); J. Stat. Mech 2024 machine learning special issue.

9. *Bayes-Optimal Learning of Deep Random Networks of Extensive Width*
   H. Cui, F. Krzakala, L. Zdeborová
   ICML 2023 **Oral** (top 2.4% of submissions); J. Stat. Mech 2024 machine learning special issue.

10. *Deterministic Equivalent and Error Universality of Deep Random Features*
    D.Schröder*, **H.Cui***, D.Dmitriev, B.Loureiro
    ICML 2023; J. Stat. Mech 2024 machine learning special issue.

11. *Error Rates for Kernel Classification under Source and Capacity conditions*
    H. Cui, B. Loureiro, F. Krzakala, L. Zdeborová
    MLST 2023

12. *Large deviations in Semi-Supervised Learning in the Stochastic Block Model*
    H. Cui, L. Saglietti, L. Zdeborová
    Phys. Rev. E 2022

13. *Generalization Error rates for Kernel Ridge Regression : the Crossover from the Noiseless to the Noisy Regime*
H. Cui, B. Loureiro, F. Krzakala, L. Zdeborová
NeurIPS 2021; J. Stat. Mech 2022 machine learning special issue.

14. *Large deviations in the perceptron model and consequences for active learning*
H. Cui, L. Saglietti, L. Zdeborová
MSML 2020 and MLST 2021

15. *Capturing the learning curves of generic features maps for realistic data sets with a teacher-student model*
B. Loureiro, C. Gerbelot, **H. Cui**, S. Goldt, F. Krzakala, M. Mézard, L. Zdeborová
NeurIPS 2021; J. Stat. Mech 2022 machine learning special issue.

PhD thesis – *Topics in statistical physics of high-dimensional machine learning*, **H. Cui**, 2024

Talks

(Talk) SIERRA seminar, Inria Paris (France)	2024
(**Invited talk**) Harvard Stats. Probabilitas seminar (USA)	2024
(Talk) Harvard CMSA member seminar (USA),	2024
(Talk) Machine Learning and Signal Processing seminar, ENS Lyon (France)	2024
(Talk) TAU seminar, Inria Paris Saclay (France)	2024
(**Invited talk**) European Conference on Optimization (EUROPT 2024) (Sweden),	2024
(**Invited talk**) Lausanne Event on ML Theory, EPFL (Switzerland)	2024
(**Invited talk**) Youth in High Dimensions, ICTP (Italy)	2024
(Talk) EPFL NeurIPS CIS event (Switzerland)	2023
(**Invited talk**) 5th International Workshop on Neural Scaling Laws (USA)	2023
(Oral) 40th International conference on machine learning (USA)	2023
(Talk) Machine Learning & Statistical Physics back together, Cargèse (France)	2023
(**Invited talk**) ITS Seminar, City University of NY (USA)	2023
(**Invited talk**) EPFL-RIKEN Young rising stars joint workshop (Switzerland)	2022
(**Invited talk**) Learning: Optimization and Stochastics Summer Research Institute (Switzerland)	2022
(Talk) Learning and Optimization conference, CIRM (France)	2022
(Talk) Advanced Course on Data and Learning (Italy), *best presentation award*	2022
(Talk) Workshop on the Theory of Overparameterized Machine Learning	2022
(Talk) NeurIPS conference 2021 (Online)	2021
(**Invited talk**) Fundamentals of Learning and AI Research (FLAIR) seminar, EPFL (Switzerland),	2021
(Talk) 1st Mathematical and Scientific Machine Learning conference (Online)	2020

Posters ——

International Conference on Learning Representations (Austria)	2024
(**spotlight**) Advances in Neural Processing Systems (NeurIPS) (USA)	2023
Workshop on artificial and biological neural networks (France)	2023
Youth in high dimensions, ICTP (Italy)	2023
4th IMA conference on the mathematical challenges of big data, Oxford (UK)	2022
Summer school on glassy systems and interdisciplinary applications, Cargèse (France),	2021

Dissemination and services

Teaching ——

Machine learning for physicists (Master), *28 hours (teaching assistant) + 2 hours (lecturer)*	EPFL, 2023
Statistical physics of learning (Master), *56 hours (teaching assistant)*	EPFL, 2022-2023
Statistical Physics II (Master) , *28 hours (teaching assistant)*	EPFL, 2022
Physics for Earth Scientists (Bachelor), *28 hours (teaching assistant)*	Lausanne Univ., 2021
Physics I (Bachelor), *28 hours (teaching assistant)*	EPFL, 2020

Reviewing ——

I am a reviewer for machine learning conferences (NeurIPS, ICML, ICLR) and physics journals (J. Stat. Mech, SciPost)

Supervision ——

Nolan Sandgathe (EPFL, Master thesis), currently data scientist at Kachan (Canada). 2023

Oscar Bouverot-Dupuis (Ecole Normale Supérieure Paris, Master internship), currently PhD student at LPTMS (Université Paris-Saclay, France). 2022

Outreach ——

Invited lecturer (panelist) at the graduate course on *science outreach and popularization* Geneva Univ., 2022

Invited jury member, Famelab science communication regional competition. 2022

Seminar organization ——

Co-organizer of the Harvard New Technologies in Mathematics seminar series. Harvard, 2024-2025