

# Hugo Cui

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## Profile

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### 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

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### Harvard University

*Independent postdoctoral researcher at the Center of Mathematical Sciences and Applications (Harvard CMSA)*

*Cambridge, USA*

*2024 –*

### EPFL

*PhD in machine learning theory and statistical physics, advised by Lenka Zdeborová*

*Lausanne, Switzerland*

*2020 – 2024*

### ENS Paris

*Masters in theoretical physics*

*Paris, France*

*2016 – 2020*

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

## Experience

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### Capital Fund Management

*Risk management Intern*

*Paris, France*

*2020*

### Institute of Theoretical Physics (CEA Saclay)

*Master thesis, with Lenka Zdeborová*

*Paris, France*

*2019*

### University of Zurich

*Master internship, theory of quantum topological materials, with Titus Neupert*

*Zurich, Switzerland*

*2018*

### Non profit —

#### Innovation Forum

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.

*Lausanne, Switzerland*

*2021*

## Awards and certifications

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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

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\* denotes equal contributions. All full-text versions are accessible from my [personal website](#).

1. *Fundamental limits of learning in sequence multi-index models and deep attention networks: High-dimensional asymptotics and sharp thresholds*  
E. Troiani, **H. Cui**, Y. Dandi, F. Krzakala, L. Zdeborová  
preprint arXiv:2502.00901
2. *A precise asymptotic analysis of learning diffusion models: theory and insights*  
**H. Cui**, C. Pehlevan, Y. M. Lu  
preprint arXiv:2501.03937
3. *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  
AISTATS 2025 Oral (top 2% of submissions)
4. *High-dimensional learning of narrow neural networks*  
**H. Cui**  
J. Stat. Mech. 2025
5. *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).
6. *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).
7. *Asymptotics of learning with deep structured (random) features*  
D.Schröder, D.Dmitriev, **H.Cui**, B.Loureiro  
ICML 2024.
8. *Analysis of learning a flow-based generative model from limited sample complexity*  
**H. Cui**, E. Vanden-Eijnden, F. Krzakala, L. Zdeborová  
ICLR 2024
9. *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.
10. *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.
11. *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.
12. *Error Rates for Kernel Classification under Source and Capacity conditions*  
**H. Cui**, B. Loureiro, F. Krzakala, L. Zdeborová  
MLST 2023

13. *Large deviations in Semi-Supervised Learning in the Stochastic Block Model*  
**H. Cui**, L. Saglietti, L. Zdeborová  
 Phys. Rev. E 2022
14. *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.
15. *Large deviations in the perceptron model and consequences for active learning*  
**H. Cui**, L. Saglietti, L. Zdeborová  
 MSML 2020 and MLST 2021
16. *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

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(Invited talk) Harvard Theory of Computation seminar	2025
(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), <i>best presentation award</i>	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

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### Teaching —

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