Hugo Koubbi

Second-year PhD student in applied mathematics
Université Paris-Dauphine PSL and Sorbonne Université

Open to internship opportunities in applied mathematics, machine learning, and the scaling of deep-learning architectures.

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Research Profile

PhD student studying **neural-network parameterization**, **scaling limits of Transformers**, and **learning dynamics**. I combine probability, dynamical systems, and machine-learning experiments to understand how deep models learn and how their representations evolve.

Selected Publications and Preprints

1. **Homogenized Transformers**
   Hugo Koubbi, Borjan Geshkovski, and Philippe Rigollet. arXiv preprint, 2026.
2. **Learning Single-Index Models via Harmonic Decomposition**
   Nirmit Joshi, **Hugo Koubbi**, Theodor Misiakiewicz, and Nathan Srebro. NeurIPS 2025.
3. **Understanding Catastrophic Forgetting In LoRA via Mean-Field Attention Dynamics**
   Hugo Koubbi, Louis Hernandez, and Matthieu Boussard. ICML 2026.
   Code
4. **Dynamic metastability in the self-attention model**
   Borjan Geshkovski, **Hugo Koubbi**, Yury Polyanskiy, and Philippe Rigollet. arXiv preprint, 2024.
   Code

Research Experience

Sept. 2025 – present
Université Paris-Dauphine PSL and Sorbonne Université
PhD student in applied mathematics; expected completion: 2028
Research on scaling limits and training dynamics of deep Transformers. Developing theoretical and computational approaches to study how learning changes with model depth and size.

Sept. 2024 – July 2025
Yale University, New Haven, USA
Visiting Assistant Researcher
Statistical estimation for single-index models using harmonic decomposition (NeurIPS 2025).

Mar. 2024 – July 2024
Inria Paris, France
Research intern
Studied long-lived clustering dynamics in self-attention models.

Sept. 2023 – Mar. 2024
Craft AI, Paris, France
Research intern, industry
Studied catastrophic forgetting under LoRA using theory and experiments on pretrained language models (ICML 2026).

Apr. 2023 – Aug. 2023
EPFL, Lausanne, Switzerland – IdePHICS group
Research intern
Studied community detection with kernel side information using statistical physics and graph-fused LASSO.

Technical Skills

Programming	Python, R
ML frameworks	PyTorch for model implementation, training, and fine-tuning of Transformers, including LoRA and other adapters
Scientific tools	NumPy, SciPy, Matplotlib; numerical optimization and PDE/ODE solvers
Tools	Git, LaTeX

Education

2021 – 2023 **Université Paris-Saclay and ENS Paris-Saclay**
M.Sc. in Probability Theory and Statistics – highest honors

2020 – 2021 **École Normale Supérieure Paris-Saclay**
B.Sc. in Mathematics – highest honors

2018 – 2020 **Lycée du Parc, Lyon, France**
Classes préparatoires MPSI–MP (mathematics and physics)*

Teaching and Mentoring

Since 2025 **Teaching assistant, Université Paris-Dauphine PSL.** Numerical optimization and differential calculus.

2026 **M1 research project supervisor, Paris-Dauphine PSL.** Supervised three master's students on scaling limits of Markov chains and ballistic/diffusive limits of SGD.

2022 – 2024 **Oral examiner, classes préparatoires.** Lycées Louis-le-Grand, Michelet, and Janson-de-Sailly.

Since 2021 **Mathematics teacher, Admi-Univ.** Undergraduate program, Paris.

Awards

2025 – 2028 **AI4IDF doctoral fellowship.** Competitive PhD funding from the Île-de-France AI cluster.

Languages

French (native) | English (fluent)