LEONARDO BANDERA

https://leonardox-8.github.io

RESEARCH INTERESTS

My current research focuses on the interface between the statistical physics of disordered systems and artificial neural networks. Interested in geometrical approaches to theoretical machine learning, high-dimensional sampling problems, generative models and computational neuroscience.

EDUCATION

Bocconi University — Milan, Italy
MASTER OF SCIENCE in ARTIFICIAL INTELLIGENCE — September 2023 - December 2025

Master's Thesis: ***A Solvable Model of Generative Diffusion and the Memorization Phenomenon***
Supervisor: professor C. Lucibello
Theoretical study of how training dynamics affect memorization in score-based generative diffusion. Focus on time-integrated model analysis and structured data sampling.

Università degli Studi di Milano — Milan, Italy
BACHELOR in MATHEMATICS — September 2019 - April 2023

RESEARCH EXPERIENCE

Random Features Score-Based Diffusion: Sampling from a Gaussian Mixture
Bocconi University, 2025
(manuscript in preparation)

This work develops a detailed theoretical characterization of both backward diffusion dynamics and training dynamics of score-based diffusion models trained on Mixture-of-Gaussians data. We show that the learning dynamics reduce to a low-rank perturbation of the Gaussian case, leading to BBP-type spectral transitions with respect to diffusion time, that govern sensitivity to informative directions. The paper provides a refined and technically deeper treatment of structured data regimes initially explored in the author's Master's thesis.
Developed in collaboration with F. Elgorni and B. Annesi under the supervision of professor C. Lucibello.

Balanced Excitatory–Inhibitory Recurrent Neural Networks
Bocconi University, 2025
(manuscript in preparation)

Developed an analytical and computational extension of the classical Brunel model with explicit excitatory and inhibitory neuronal populations. Performed mean-field analysis of large recurrent networks to characterize asynchronous irregular and fluctuation-driven regimes, and studied the role of excitation–inhibition balance in determining stability, collective dynamics, and variability. Validated analytical predictions through large-scale numerical simulations and investigated finite-size effects.
Research conducted in collaboration with G. Bruno under the supervision of professor N. Brunel.

TECHNICAL SKILLS

Programming: Python, Julia, C, C++

Machine Learning Frameworks: PyTorch, TensorFlow, JAX

Tools: Git, LaTeX, Lyx

INDUSTRY EXPERIENCE

INTESA SANPAOLO — Milan, Italy
AI Consultant — September 2024 - March 2025
Designed and analyzed LLM-based systems for document generation tasks.

HOBBIES

- **Basketball**: Former **Olimpia Milano** youth player (2012-2016), currently competing in Italian **Serie D**.
- **Music**: Passionate guitarist, attended **Berklee College of Music Summer Program** (2018).