Dottorato di Ricerca in Fisica
(XLI Ciclo)

Proposta di Progetto di Ricerca

Stochastic Dynamics and Large Deviations in High-Dimensional Learning: A Statistical Physics Perspective on Deep and Recurrent Networks

Abstract:
Understanding the dynamics of learning in deep and recurrent neural networks requires going beyond classical optimization frameworks like stochastic gradient descent (SGD). This project investigates the role of stochasticity and high-dimensional fluctuations in learning, with a focus on **large deviation phenomena** and **non-equilibrium statistical physics**. We aim to characterize how rare but influential trajectories shape learning outcomes, generalization, and memory in complex models. By analyzing the energy landscapes and transition dynamics of neural systems, we seek to develop **dynamical algorithms** that better reflect the mechanisms observed in real-world learning, both biological and artificial. These methods move beyond gradient-based rules, incorporating noise, temporal correlations, and path-dependent effects to capture richer, more realistic learning behavior.

Contact: raffaella.burioni@unipr.it