Bocconi

18 SEPTEMBER 2025
12:00 PM

Bocconi University
Room 2-E4-SR03
Via Röntgen 1, Milano (2° floor)

Stochastic Differential Equations as a Lens on Optimization Dynamics

Speaker

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Abstract

Stochastic differential equations (SDEs) provide a powerful framework for understanding the dynamics of modern optimization methods in machine learning. By embedding discrete updates into continuous-time stochastic processes, one can uncover structural properties and implicit biases that remain hidden in standard analyses. In recent work, I have used this perspective to gain new insights into adaptive methods, minimax optimization, distributed algorithms, and differentially private training.

In this talk, I will introduce the SDE framework for optimization, starting from the derivation of SGD and extending it to Sharpness-Aware Minimization (SAM). I will then focus on the Unnormalized SAM variant, showing how its SDE dynamics explain the preference for flatter minima through implicit regularization and curvature-aware noise. Finally, I will present additional results for the widely used AdamW optimizer, providing further evidence of the versatility of this approach and its ability to unify our understanding of diverse optimization methods.