Contribution ID: **103** Type: **Tutorial courses**

A statistical physics perspective on the theory of machine learning

Wednesday, 15 April 2026 08:30 (1h 30m)

The past decade has witnessed a surge in the development and adoption of machine learning algorithms to solve day-a-day computational tasks. Yet, a solid theoretical understanding of even the most basic tools used in practice is still lacking, as traditional statistical learning methods are unfit to deal with the modern regime in which the number of model parameters are of the same order as the quantity of data – a problem known as the curse of dimensionality. Curiously, this is precisely the regime studied by Physicists since the mid 19th century in the context of interacting many-particle systems. This connection, which was first established in the seminal work of Elisabeth Gardner and Bernard Derrida in the 80s, is the basis of a long and fruitful marriage between these two fields.

The goal of this mini-course is to provide an in-depth overview of these connections and a good vision of the different tools available in the statistical physics toolbox, as well as their scope and limitations.

Syllabus:

- Historical overview of the connections between Statistical Physics and Computer Science.
- Mean-Field Models 101: Curie-Weiss Model
- Statistical-to-Computational Gaps
- The double-descent phenomena and benign overfitting (time permitting)

Bibliography:

The mini-course will the based on the following lectures notes: https://brloureiro.github.io/assets/pdf/NotesPrinceton_BL.pdf

Primary author: LOUREIRO, Bruno (ENS Paris)

Presenter: LOUREIRO, Bruno (ENS Paris)

Session Classification: Tutorial courses

Track Classification: Statistical Physics