MPI-DS Seminar

MAX PLANCK INSTITUTE
FOR DYNAMICS AND
SELF-ORGANIZATION

From emergent behavior in many-body systems to its usefulness in machine learning and unconventional computing

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Many-body model systems have been incredibly important for fundamental understanding and theoretical development in soft and hard condensed matter physics. Of central importance are the emergence of phase transitions as well as nonequilibrium collective phenomena under driving. Phenomena at the macroscopic scale happen innately due to the interactions of microscopic constituents. In this talk, we first illustrate the shape-shifting properties of such model systems, which come forth under nonequilibrium conditions – we use the example of simple hard-rod models on lattices (in confinement). Then, we discuss how such properties can be useful for machine learning in two different ways: first, as a sophisticated means to interpret and test modern 'black box' machine learning algorithms, and therewith to offer an assessment of their limits and capabilities. We show results for generative models trained on data from hard-rod model systems. Secondly, we set off to explore how the nonequilibrium dynamics of many-body systems can be useful in and of itself for learning and unconventional computation. For example, the dynamics of active-matter model systems can be used for reservoir computing. A few ideas regarding other learning and computation paradigms are discussed briefly, as well.

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