Dipartimento di Fisica e Sezione INFN di Torino

PHYSICS COLLOQUIUM

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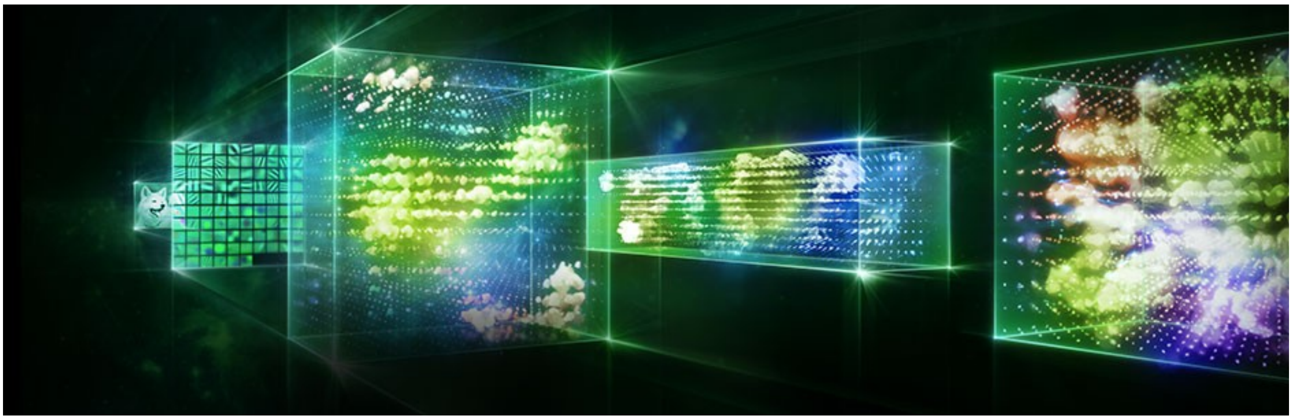

The physics of Artificial intelligence

In many applications Artificial Intelligence (AI) is reaching abilities that are comparable to those of human beings, if not better. These achievements were still impossible ten years ago and their technological follow-ups are rapidly impacting our societies. The main current tools of AI are artificial deep neural networks (nonlinear devices with hundreds of millions of connections) inspired by the human visual systems. The ability of deep artificial neural networks to learn efficiently from unorganized and huge data sets is inspiring researchers to think about artificial intelligence in an unprecedented way. Still the field is under many aspects heuristic and there is an urgent need for an in-depth theoretical comprehension. Learning is, in principle, a hard problem in deep neural networks. However, while standard techniques fail badly, in practice heuristic algorithms often find solutions with surprisingly good generalization properties. We discuss an explanation of this behavior in terms of a non-equilibrium statistical physics framework: we show that there exist rare regions of the optimization landscape that are both robust and accessible to out-of-equilibrium stochastic processes and that their existence is crucial to achieve good performance. Building on these analytical results, we provide a unified framework for understanding the success of the current learning algorithms and show how novel stochastic algorithmic schemes can be derived.