Bocconi

Universal representation by Boltzmann machines with Regularised Axons

Speaker

Maciej Lewenstein
Head of the Quantum Optics
Theory group
ICFO Institute of Barcelona

Abstract

It is widely known that Boltzmann machines are capable of representing arbitrary probability distributions over the values of their visible neurons, given enough hidden ones. However, sampling and thus training these models can be numerically hard. Recently we proposed a regularisation of the connections of Boltzmann machines, in order to control the energy landscape of the model, paving a way for efficient sampling and training. Here we formally prove that such regularised Boltzmann machines preserve the ability to represent arbitrary distributions. This is in conjunction with controlling the number of energy local minima, thus enabling easy guided sampling and training.

Furthermore, we explicitly show that regularised Boltzmann machines can store exponentially many arbitrarily correlated visible patterns with perfect retrieval, and we connect them to the Dense Associative Memory networks.

[1] Alejandro Pozas-Kerstjens, Gorka Muñoz-Gil, Miguel Ángel García-March, Antonio Acín, Maciej Lewenstein, and Przemysław R. Grzybowski, Efficient training of energy-based models via spin-glass control, Mach. Learn.: Sci. Technol.2 025026 (2021)

[2] Przemysław R. Grzybowski, Antoni Jankiewicz, Eloy Piñol, David Cirauqui, Dorota H. Grzybowska, Paweł M. Petrykowski, Miguel Ángel García-March, Maciej Lewenstein, Gorka Muñoz-Gil, and Alejandro Pozas-Kerstjens, Universal representation by Boltzmann machines with Regularised Axons, arXiv:2310.14395

Università
Bocconi

DEPARTMENT
OF COMPUTING
SCIENCES