## Probing many-body localization with neural networks

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Machine learning is a booming technique for analyzing big amounts of data, in particular since the rise of deep neural networks a few years ago. Very recently, these methods have been applied to quantum many-body systems in various contexts. I will discuss how artificial neural networks can be employed to classify phases of matter. While the approach that I will present can be applied to various classification problems of this type, I will use the example of distinguishing a thermalizing from a many-body localized phase. Many-Body localization is a phenomenon by which interacting quantum systems evade following the rules of conventional statistical mechanics, in particular they are not ergodic. Instead they retain memory of their initial conditions for arbitrary long times. Specifically, I will use entanglement spectra of the Heisenberg spin-1/2 chain in a random external field , which exhibits a many-body localized phase at strong disorder, as input for the neural network. While the network is trained on entanglement spectra deep in either phase, it is then applied to classify spectra belonging to states in the phase transition region. The resulting phase diagram is in remarkable agreement with the one obtained by more conventional methods and can be computed for small systems. I furthermore discuss the entanglement structure of individual eigenstates which can be mapped out with spatial resolution using this method. The structure elements of the network that are crucial for the correct classification are presented. In particular, the network features an element that encourages confident classification of states close to the phase transition. This conference optimization as well as other regularization that I will discuss are important for a reliable operation of the network. Finally, I will mention how the robustness of these results can be tested using a neural network technique called dreaming, where a known power law behavior of entanglement spectra in the many-body localized phase is recovered.