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Reverse engineering Hamiltonian from spectrum

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Handling the large number of degrees of freedom with proper approximations, namely the construction of the effective Hamiltonian is at the heart of the (condensed matter) physics. Here we propose a simple scheme of constructing Hamiltonians from given energy spectrum. The sparse nature of the physical Hamiltonians allows us to formulate this as a solvable supervised learning problem. Taking a simple model of correlated electron systems, we demonstrate the data-driven construction of its low-energy effective model. Moreover, we find that the same approach works for the construction of the entanglement Hamiltonian of a given quantum many-body state from its entanglement spectrum. Compared to the known approach based on the full diagonalization of the reduced density matrix, our one is computationally much cheeper thus offering a way of studying the entanglement nature of large (sub)systems under various boundary conditions.

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