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Classical approximation algorithms for quantum constraint satisfaction problems

The study of approximation algorithms for Boolean satisfiability problems such as MAX-k-SAT is a well-established line of research. In the quantum setting, there is a physically motivated generalization of MAX-k-SAT known as the k-Local Hamiltonian problem (k-LH), which is of interest for two reasons: From a complexity theoretic perspective, k-LH is complete for the quantum analogue of NP, and from a physics perspective, k-LH asks one to estimate the energy of a quantum system when cooled to very low temperatures. For the latter reason in particular, the condensed matter physics community has devoted decades to developing heuristic algorithms for k-LH and related problems. However, recent years have witnessed the development of the first classical approximation algorithms for k-LH, which shall be the focus of this talk. We will begin with an introductory overview of some existing results, with no background in quantum computing assumed. We will then discuss recent work in progress on generalizing the celebrated Goemans-Williamson algorithm for MAX-CUT to approximate physically motivated special cases of k-LH. The latter is joint work with Yi-Kai Liu (NIST, USA).