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Quantum Error Correction for Minor Embedded Quantum Annealing WALTER VINCI, University of Southern California, GERARDO PAZ SILVA, Dartmouth College, ANURAG MISHRA, TAMEEM ALBASH, DANIEL LIDAR, University of Southern California — While quantum annealing can take advantage of the intrinsic robustness of adiabatic dynamics, some form of quantum error correction (QEC) is necessary in order to preserve its advantages over classical computation. Moreover, realistic quantum annealers are subject to a restricted connectivity between qubits. Minor embedding techniques use several physical qubits to represent a single logical qubit with a larger set of interactions, but necessarily introduce new types of errors (whenever the physical qubits corresponding to the same logical qubit disagree). We present a QEC scheme where a minor embedding is used to generate a $8 \times 8 \times 2$ cubic connectivity out of the native one and perform experiments on a D-Wave quantum annealer. Using a combination of optimized encoding and decoding techniques, our scheme enables the D-Wave device to solve minor embedded hard instances at least as well as it would on a native implementation. Our work is a proof-of-concept that minor embedding can be advantageously implemented in order to increase both the robustness and the connectivity of a programmable quantum annealer. Applied in conjunction with decoding techniques, this paves the way toward scalable quantum annealing with applications to hard optimization problems.

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