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Poster Abstract Submission to QIP 2023

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We present a fast and Bayes-optimal-approximating tensor network decoder for quantum LDPC codes based on the tensor-entanglement renormalization group algorithm, originally proposed by Gu, Levin, and Wen. By precomputing the renormalization group flow for the null syndrome, we need only recompute tensor contractions in the causal cone of the measured syndrome at the time of decoding. This allows us to achieve an overall runtime complexity of ${\cal O}(pn\chi^6)$ where p is the depolarizing noise rate, and χ is the cutoff value used to control singular value decomposition approximations used in the algorithm. We apply our decoder to the surface code in the code capacity noise model and compare its performance to the original matrix product state (MPS) tensor network decoder introduced by Bravyi, Suchara, and Vargo. The MPS decoder has a p-independent runtime complexity of ${\cal O}(n\chi^3)$ resulting in significantly slower decoding times compared to our algorithm in the low-p regime.

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