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Randomized algorithms for streaming low-rank approximation in tree tensor network format

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In this work, we present the tree tensor network Nyström (TTNN), an algorithm that extends recent research on streamable tensor approximation, such as for Tucker or tensor-train formats, to the more general tree tensor network format, enabling a unified treatment of various existing methods. Our method retains the key features of the generalized Nyström approximation for matrices, i.e. it is randomized, single-pass, streamable, and cost-effective. Additionally, the structure of the sketching allows for parallel implementation. We provide a deterministic error bound for the algorithm and, in the specific case of Gaussian dimension reduction maps, also a probabilistic one. We also introduce a sequential variant of the algorithm, referred to as sequential tree tensor network Nyström (STTNN), which offers better performance for dense tensors. Furthermore, both algorithms are well-suited for the recompression or rounding of tensors in the tree tensor network format. Numerical experiments highlight the efficiency and effectiveness of the proposed methods.

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