

Publication

Algorithmic patterns for H matrices on many-core processors

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In this work, we consider the reformulation of hierarchical (H) matrix algorithms for many-core processors with a model implementation on graphics processing units (GPUs). H matrices approximate specific dense matrices, e.g., from discretized integral equations or kernel ridge regression, leading to log-linear time complexity in dense matrix-vector products. The parallelization of H matrix operations on many-core processors is difficult due to the complex nature of the underlying algorithms. While previous algorithmic advances for many-core hardware focused on accelerating existing H matrix CPU implementations by many-core processors, we here aim at totally relying on that processor type. As main contribution, we introduce the necessary parallel algorithmic patterns allowing to map the full H matrix construction and the fast matrix-vector product to many-core hardware. Here, crucial ingredients are space filling curves, parallel tree traversal and batching of linear algebra operations. The resulting model GPU implementation hmglib is the, to the best of the authors knowledge, first entirely GPU-based Open Source H matrix library of this kind. We conclude this work by an in-depth performance analysis and a comparative performance study against a standard H matrix library, highlighting profound speedups of our many-core parallel approach.

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