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Jianlin Xia* (xiaj@math.purdue.edu). *Multi-layer Structures for the Direct Solution of Multi-Dimensional Discretized Problems.*

We propose multi-layer hierarchically semiseparable (MHS) structures for the efficient factorizations of dense matrices arising from high dimensional discretized problems. The problems include discretized integral equations and dense Schur complements in the factorizations of discretized PDEs. Unlike existing work on hierarchically semiseparable (HSS) structures which is essentially 1D, the MHS framework integrates multiple layers of rank and tree structures. We lay theoretical foundations for MHS structures and justify the feasibility of MHS approximations for these dense matrices. Rigorous rank bounds for the low-rank structures are given. Representative subsets of mesh points are used to illustrate the multi-layer structures as well as the structured factorization. Systematic fast and stable MHS algorithms are proposed, particularly convenient direct factorizations. The new structures and algorithms can yield direct solvers with nearly linear complexity and linear storage for solving some practical 2D and 3D problems. (Received August 10, 2015)