**Tensor star-M product SVDs for compression, with applications in POD and in system identification.**

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The tensor-tensor algebras proposed first by Kilmer and Martin (LAA 2011) and extended by Kernfeld, et al (LAA 2015) offer matrix-mimetic properties. Importantly, the algebras admit tensor SVDs that resemble their matrix counterparts. Classes of these tensor SVDs were recently shown to satisfy Eckart -Young theorems (Kilmer, et al, arXiv 2019). Such theorems offer implicit recipes for data compression. We first give theoretical results showing that compression with these tensor-SVD variants can lead to better compression than traditional matrix-based techniques. The proofs of the theorems rely on latent structure induced by the choice of the tensor-tensor product together with structure that is relevant in the data. Considering snapshot data in tensor format, we illustrate how our tensor methods can be applied in the context of POD. Further, defining an invertible mapping between structured matrix operators and tensors and utilizing our tensor compression techniques, we give new methods to approximate the matrix operator by one of Kronecker-type. We then show how this operator decomposition can be used to find a low-rank operator approximation in a system identification application.