Dynamical Low Rank Approximation of Tensors

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joint work with Ch. Lubich

For the low rank approximation of time-dependent data tensors and of solutions to tensor differential equations, for example resulting from space semi-discretization of partial differential equations, an increment based computational approach is proposed and analyzed. In this variational method, the derivative is projected onto the tangent space of the manifold of low rank tensors at the current approximation. This yields nonlinear ordinary differential equations that are well-suited for numerical integration. The error analysis compares the result with the pointwise best approximation computed by higher order singular value decomposition. It is proven for the matrix case, corresponding to tensors of order two, that the approach gives locally quasi-optimal low rank approximations. The extension of the analysis to higher-order tensors is outlined and the implications for variational approximations in quantum dynamics are indicated. Numerical experiments illustrate the theoretical results.

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