Fast Solvers for Isogeometric Analysis based on Alternating Linear Schemes for Tucker Tensors

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ABSTRACT

We consider the construction of fast and memory-efficient solvers for tensor product Isogeometric Analysis by means of low-rank approximation. In particular, we investigate the approximation of the solution fields by means of Tucker tensors, a format for low-rank representation of tensor which is based on the construction of a small tensor product subspace of the tensor product spline space. We then propose an iterative method for the approximation of the solution of the discretized IgA equation based on a so-called Alternating Linear Scheme. The idea is to reduce the nonlinear best tensor approximation problem in the energy norm to a series of linear approximation problems for the individual factors of the Tucker tensor. By alternating between solving these linear problems and updating the corresponding factors of the Tucker representation, we can expect to converge to the best low-rank approximation of the solution in the energy norm.

We study several numerical examples in 2D and 3D where the proposed solution method exhibits very robust performance in both the spline degree and the geometry mapping.