Decoupled isogeometric discretizations using low-rank approximation

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Isogeometric discretizations provide a generalization of the isoparametric concept of classical finite element methods. A notable difference is the fact that in isoparametric methods a local geometry map is used to forward the reference element to the computational domain. In NURBS-based isogeometric analysis the reference element is substituted by a structured collection of parametric elements and the local geometry map is replaced by a global one, acting on all parametric elements.

Isogeometric discretizations using tensor-product B-splines on three-dimensional or four-dimensional (space-time) domains require expensive numerical cubature to evaluate tri-variate or higher-dimensional integrals. In this talk we discuss a preprocessing step, which reduces this cubature to the treatment of a few lower-dimensional numerical integration problems. The core of the method is partial tensor decomposition, which is achieved by performing (truncated) singular value decomposition. The latter is widely available in linear algebra software suites, and highly optimized. We analyze the computational complexity of the approach and we demonstrate the its advantage on the overall computation times, both theoretically and in actual run-times of computationally demanding isogeometric simulations.