LOW-RANK METHODS AND SOLVERS FOR ISOGEOMETRIC ANALYSIS

MONICA MONTARDINI

Università di Pavia, Pavia, Italy

Similarly to other numerical methods to solve Partial Differential Equations (PDEs), computing the solution of PDEs with Isogeometric Analysis suffers from the so-called curse of dimensionality, i.e. memory storage and computational effort grow exponentially with respect to the dimension of the problem. In this talk we propose low-rank techniques that can overcome this issue with the aim of computing the solution with roughly $O(n)$ FLOPs, where n is the number of univariate degrees of freedom [1]. A low-rank decomposition of the linear system matrix kernel is combined with a new suited iterative solver. In particular, the non-tensor product coefficients are approximated with the sum of few Kronecker-product functions, and thus the linear system matrix results in the sum of few Kronecker-product matrices. This yields a small memory footprint and cost for the matrix products. The techniques to approximate the linear system matrix in low-rank format are already present in literature. The novelty of our work is the development of a specialized iterative solver combined with a preconditioning strategy. This low-rank technique and the preconditioning strategy can be extended to multipatch geometries, using an overlapping Schwarz method where the subdomains can be defined as unions of neighbouring patches [2]. Finally, we also show some numerical experiments.

References

[1] M. Montardini, G. Sangalli, and M. Tani. A low-rank isogeometric solver based on Tucker tensors. *Comput. Methods Appl. Mech. Engrg.*, page 116472, 2023.

[2] M. Montardini, G. Sangalli, and M. Tani. A low-rank solver for conforming multipatch Isogeometric Analysis. *arXiv preprint. arXiv:2312.08736* [*math.NA*].