Johann Radon Institute for Computational and Applied Mathematics Austrian Academy of Sciences (ÖAW)

Colloquium

Computational Methods for PDEs

Fast algorithms for tensor product discretizations in Isogeometric Analysis and beyond

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Abstract

In this talk, we consider discretizations of partial differential equations which have an underlying tensor product structure (e.g., are posed in a square or cube domain) and ask the question: how can we exploit this underlying structure in order to obtain faster algorithms for the generation and solution of the discretized problem?
Although this assumption of tensor product structure is quite strong, there has recently been renewed interest in such algorithms due to the rise of Isogeometric Analysis. This young competitor to the Finite Element Method relies strongly on tensor product spline spaces and allows the treatment of more complicated computational domains while preserving the underlying tensor product structure of the discretization space.
We will consider various problems, such as the fast formation of the isogeometric stiffness matrices, the development of multigrid solvers which are robust with respect to the spline degree, and the construction of solvers which mitigate the exponential dependence on the space dimension, where the tensor product structure can be exploited in order to achieve significant speedups over classical techniques. In several situations, methods of low-rank matrix and tensor approximation come into play.
Although the focus of the talk is on applications in Isogeometric Analysis, most of the developed techniques are rather general and can be used for different discretization techniques. As a particularly timely application, we will see some results for the solution of fractional diffusion problems in general domains.