MS 4: Domain Decomposition Methods and Applications to Control Problems

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ABSTRACT

Algorithms for PDE constrained optimization problems are extremely demanding in computer ressources: they require in general multiple solutions of partial differential equations during the iterative process of the nonlinear optimization strategy. This minisymposium shows how domain decomposition methods can be effectively used to parallelize large scale simulations within the optimization iteration, and also points out new directions in domain decomposition.

SPEAKERS

1. Oliver Rheinbach (TU Freiberg)
   Title: FETI-DP methods for Optimal Control Problems

2. Julien Salomon (Université Paris-Dauphine)
   Title: An intermediate states method for the time-parallelized solving of optimal control problems

3. Kevin Santugini (Institut Polytechnique de Bordeaux)
   Title: A new discontinuous coarse space correction algorithm for Optimized Schwarz Methods

4. Lorenz John (TU Graz)
   Title: Schur complement preconditioners for the biharmonic Dirichlet boundary value problem and applications to boundary control problems

FETI-DP methods for Optimal Control Problems

Roland Herzog*and Oliver Rheinbach†

We present a dual-primal FETI method applied to the optimal control of two dimensional linear elasticity problems. The numerical results are similar to the ones presented by Heinkenschloss and Nguyen (2006) for balancing Neumann-Neumann and seem to indicate numerical scalability with respect to the number of subdomains and robustness with respect to the cost parameter α.

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An intermediate states method for the time-parallelized solving of optimal control problems

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In this talk, we present a general approach to parallelize efficiently optimal control solvers. This method, first introduced in 2006, is based on the introduction of intermediate states that enables one to decompose the original optimality system into similar sub-systems. These ones can then be treated independently using standard solvers. We present a recent improvement of the method that makes it fully efficient and discuss the role of the solver used in parallel.

A new discontinuous coarse space correction algorithm for Optimized Schwarz Methods

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For domain decomposition methods that produce discontinuous iterates such as Optimized Schwarz methods, it is advantageous for the coarse space to be discontinuous so as to be able to correct discontinuities during the coarse correction step. In this presentation, we introduce a new coarse space correction using the discontinuous coarse spaces introduced in DD21. The basic idea is to choose the coarse corrector that minimizes the jump of the optimized transmission conditions. A major difference is that the new algorithm is designed with a cell centered finite volume discretization in mind, in contrary to the previous discontinuous coarse space algorithm that was designed for finite element discretizations.

Schur complement preconditioners for the biharmonic Dirichlet boundary value problem and applications to boundary control problems

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We propose and analyse preconditioners for the Schur complement matrix of a mixed finite element discretisation of the biharmonic Dirichlet boundary value problem. Since the system matrix is spectrally equivalent to the piecewise defined Sobolev space $\widetilde{H}^{-1/2}_{\mathrm{pw}}(\Gamma)$ we may use either an appropriate boundary element approximation of local single layer boundary integral operators to define an optimal preconditioner, or we may consider a multilevel preconditioner where the resulting spectral condition number is only optimal up to logarithmic terms. The multilevel preconditioner is then applied to the solution of unconstrained boundary control problems by using induced energy norms to describe the involved cost or regularisation. It turns out that the system matrices of the Dirichlet and Neumann control problems coincide which unifies the applied solution strategy. This approach can also be applied to the particular case of a Neumann control problem for the Laplace equation without any further modification. Numerical experiments confirm all the theoretical results.