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Systematic construction of coarse spaces for tw decomposition methods

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Efficiently solving partial differential equations with highly heterogeneous and multiscale coefficients is challenging, in particular from the need to solve large-scale and ill-conditioned linear systems. Domain decomposition methods address this by constructing preconditioners that solve independent local problems in parallel, to be used in iterative solvers. A key aspect to achieve scalability and robustness in these methods is the incorporation of a suitable coarse space. This presentation begins with an overview of one-level preconditioners, then introduces a novel construction of coarse spaces for two-level methods. The analysis is broadly applicable, encompassing both symmetric and non-symmetric problems, as well as symmetric preconditioners like the additive Schwarz method and non-symmetric ones such as the restricted additive Schwarz method. It can also account for both exact and inexact subdomain solves. The coarse space is constructed by solving local generalized eigenproblems within each subdomain and applying a carefully chosen operator to the selected eigenvectors. This talk is mainly based on a joint work with Frédéric Nataf and Pierre-Henri Tournier.

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