Title: A fully algebraic spectral coarse space for overlapping Schwarz methods

Abstract: Discretizing partial differential equations often results in sparse systems of linear equations. High spatial resolutions lead to large systems, which can be solved efficiently using iterative methods. A suitable class of solvers are Krylov methods preconditioned by domain decomposition preconditioners, which are scalable and robust for a wide range of problems. Unfortunately, highly heterogeneous problems arising, for instance, in the simulation of composite materials or porous media generally lead to unfavorable distributions of the eigenvalues of the system matrix that cause slow convergence for many solvers, including classical domain decomposition preconditioners.

In order to retain robustness of domain decomposition methods, the coarse space can be enriched by additional coarse basis functions computed from eigenmodes of local generalized eigenvalue problems, leading to so-called spectral or adaptive coarse spaces. The development of spectral coarse spaces for domain decomposition methods has been a very active topic within the last decade. However, until recently, the algebraic construction of robust spectral coarse spaces, that is, using only the fully assembled system matrix without additional Neumann matrices or geometrical information, has still been on open problem.

This talk deals with a specific class of adaptive coarse spaces for overlapping Schwarz methods which are based on a partition of the interface of the corresponding nonoverlapping domain decomposition. An algebraic and robust spectral coarse space is then constructed by solving two eigenvalue problems on each edge of a two-dimensional domain decomposition. One of them is based on optimal local approximation spaces that are also successfully employed in the construction of multiscale discretizations. The resulting condition number bound is independent of the contrast of the coefficient function, indicating the robustness of the method.

In order investigate the robustness of this new method numerically, numerical results for different coefficient distributions with large jumps are presented, including typical examples with channels, random distributions, and coefficient distributions generated from the SPE10 benchmark.