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Sparsified Coarsening Multigrid for Convection Diffusion

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Traditional algebraic multigrid (AMG) methods use (Petrov-)Galerkin coarsening where the sparsity pattern and operator complexity of the multigrid hierarchy is dictated by the multigrid transfer operators. Therefore, AMG algorithms usually compromise between the quality of these operators and the aggressiveness of the coarsening, which affects their rate of convergence and operator complexity. In many scenarios, the multigrid coarse operators tend to be much denser than the fine operator as the coarsening progresses. Such behavior is especially problematic in parallel AMG computations where it imposes expensive communication overhead. In this work we present a new algebraic technique for controlling the sparsity pattern of the operators in the multigrid hierarchy, independently of the choice of transfer operators. Our algorithm sparsifies the (Petrov-)Galerkin operators while preserving their right and left near null-spaces. Numerical experiments for Convection Diffusion problems demonstrate the efficiency and potential of this multigrid approach.