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Validation and Optimization of the Convergence Rate on Semi-structured Meshes using the LFA

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The local Fourier analysis (LFA) is an excellent tool to estimate asymptotic convergence factors for iterative solvers. The assumptions for the LFA incorporate structured grids, which makes the LFA hard to apply for arbitrary Finite Element (FE) meshes. Semi-structured meshes at least partly fulfill this requirement. In this talk we compare measured convergence rates from the Finite Element program Hierarchical Hybrid Grids (HHG) with predictions of the LFA for a two-grid multigrid cycle. HHG operates on 15-point stencils resulting from a Finite Element discretization on semi-structured three-dimensional tetrahedral meshes. Using these stencils the accordance for four iterative smoothers between a structured region of HHG and the LFA for differently shaped tetrahedral elements will be discussed. Representatives for the point-wise relaxation schemes are the Jacobi, a lexicographic and a four-color Gauss-Seidel smoother. Also results of a lexicographic line smoother are presented.

Further we want to have a look how predictions of structured regions can improve the overall convergence by redistributing the smoothing steps over the domain. The convergence rates of the structured regions will control this redistribution procedure. To determine the convergence rates, we compare two approaches, one based on a look-up table, the other one based on a direct LFA prediction, in a numerical experiment.

Key words: multigrid, local fourier analysis, convergence rates, smoothers