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Smoothed Aggregation Solvers for Anisotropic Diffusion

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A smoothed aggregation-based algebraic multigrid solver for anisotropic diffusion problems is presented. Algebraic multigrid (AMG) is a popular and effective method for solving sparse linear systems that arise from discretizing partial differential equations. However while AMG was designed for elliptic problems, the case of non-grid-aligned anisotropic diffusion is not adequately addressed by existing methods. Importantly, it is shown that neither new coarsening nor new relaxation strategies are necessary for scalable performance. Instead, a smoothed aggregation approach is developed that uses a sophisticated energy-minimizing prolongation smoother to produce a novel interpolation strategy. The goal is to produce interpolation operators for the non-grid-aligned case that are as effective as those for the grid-aligned case, which is known to have scalable multigrid solvers. As a guide for determining effectiveness, a measure for closeness to the ideal prolongator is used. Key components are large interpolation stencils and coarse grid injection. The paper concludes with encouraging numerical results that also show a potential broad applicability to other problems, such as elasticity.