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An algebraic multigrid method with guaranteed convergence rate II: The nonsymmetric case

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We consider aggregation-based algebraic multigrid and focus on the class of M-matrices with both nonnegative row and column sum. This includes matrices arising from (stabilized) low order finite difference or finite element discretizations of convection diffusion equations with divergence free convective flow.

We first consider a simplified two-grid method with just one damped Jacobi post-smoothing step. We show that the corresponding convergence factor can be bounded as a function of the convergence factor of the same scheme applied to the symmetric part of the matrix. Hence we can essentially reuse the methodology developed for the symmetric case in [1]; that is, form aggregates in such a way that a prescribed (user defined) bound holds on the convergence factor.

Nonsymmetric problems raise however several issues that are not yet covered by a proper theoretical analysis: the use of more efficient smoothing schemes such as Gauss-Seidel; the influence of non-normality; the recursive use of the method in a truly multilevel algorithm. These aspects will be discussed in detail with the help of illustrative numerical experiments.

[1] A. Napov and Y. Notay, *An algebraic multigrid method with guaranteed convergence rate*, Report GANMN 10-03, http://mntek3.ulb.ac.be/pub/docs/reports/pdf/ganmn1003.pd