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Analysis of block GMRES using a *-algebra-based approach

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We discuss the challenges of extending convergence results of classical Krylov subspace methods to their block counterparts and propose a new approach to this analysis. Block KSMs such as block GMRES are generalizations of classical KSMs, and are meant to iteratively solve linear systems with multiple right-hand sides (a.k.a. a block right-hand side) all-at-once rather than individually. However, this all-at-once approach has made analysis of these methods more difficult than for classical KSMs because of the interaction of the different right-hand sides. We have proposed an approach built on interpreting the coefficient matrix and block right-hand side as being a matrix and vector over a *-algebra of square matrices. This allows us to sequester the interactions between the right-hand sides into the elements of the *–algebra and (in the case of GMRES) extend some classical GMRES convergence results to the block setting. We then discuss some challenges which remain and some ideas for how to proceed.

This is joint work with Marie Kubiínová from Czech Academy of Sciences, Institute of Geonics, Ostrava, Czech Republic (formerly)

[1] Marie Kubínová and Kirk M. Soodhalter. Admissible and attainable convergence behavior of block Arnoldi and GMRES. SIAM Journal on Matrix Analysis and Applications, 41 (2), pp. 464-486, 2020.

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