S-STEP AND FLEXIBLE ENLARGED CONJUGATE GRADIENT METHODS

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In [2], a new approach for reducing communication in Krylov subspace methods was introduced. It consists of enlarging the Krylov subspace by a maximum of t vectors per iteration, based on a domain decomposition of the graph of A. Therefore, the approximate solutions of the system $Ax = b$ are sought from the enlarged Krylov subspace, which is a superset of the Krylov subspace. Several enlarged conjugate gradient versions that converge faster than CG in terms of iterations were introduced, such as MSDO-CG and SRE-CG. To further speedup the parallel runtime, the s-step enlarged CG versions [1] are presented, whereby s iterations of the enlarged CG methods are merged into one iteration, by performing denser operations that require less communications when parallelized. The s-step enlarged CG methods, similarly to the enlarged CG methods, converge faster than classical CG in terms of iterations, but require much more memory per iteration. Thus, we explore different options for reducing the memory requirements of these enlarged CG methods, without affecting much their convergence. This leads to the flexible enlarged CG versions, where at some iteration the maximum number of introduced basis vectors is halved. Convergence results are presented.

References

[1] S. Moufawad. *S-Step Enlarged Krylov Subspace Conjugate Gradient methods*, SIAM Journal on Scientific Computing, 42:1, pp. A187–A219, 2020.

[2] L. Grigori and S. Moufawad and F. Nataf. *Enlarged Krylov Subspace Conjugate Gradient methods for Reducing Communication.* SIAM Journal on Matrix Analysis and Applications, 37:2, pp. 744–773, 2016.