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S-Step Enlarged Conjugate Gradient Methods

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In many numerical simulations, there is a need to solve a sparse linear system ($Ax = b$) at every iteration. The solution of these linear systems, using iterative methods such as Krylov Subspace Methods, consumes around 80% of the simulation's runtime on modern architectures. Recently, enlarged Krylov subspace methods were introduced in the aim of reducing communication and speeding-up the convergence of Krylov subspace methods, thus minimizing the energy consumption. These enlarged Krylov subspace methods consist of enlarging the Krylov subspace by a maximum of t vectors per iteration based on a domain decomposition of the graph of A. In this talk, we present s-step enlarged Krylov subspace methods, whereby s iterations of enlarged Krylov subspace methods are merged to further reduce communication. We introduce several s-step enlarged CG versions (SRE-CG, MSDO-CG) and discuss their numerical stability.

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