Maximum attainable accuracy of some Krylov subspace methods for saddle point problems

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Abstract

In this contribution we study numerical behavior of several iterative Krylov subspace solvers applied to the solution of large-scale saddle point problems. Two main representatives of the segregated solution approach are analyzed: the Schur complement reduction method, based on an (iterative) elimination of primary variables and the null-space projection method which relies on a basis for the null-space for the constraints. Theoretical properties of the most frequently used stationary iterative methods and conjugate gradient-type methods when implemented to the Schur comlement or the projected system are studied and the numerical behavior of resulting schemes is discussed. We will show that rounding errors may considerably influence the numerical behavior of the resulting scheme. It is shown that depending on the considered scheme the maximum attainable accuracy of the approximate solution computed in a finite precision arithmetic can be related for most of them to the convergence of unknowns corresponding either to primary or dual variables. The necessity of pre-scaling or applying a safeguarding technique can ensure not only the convergence of the method, but it may lead to a higher maximum attainable accuracy of (all) iterates computed in finite precision arithmetic.

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