Special Volume on Saddle Point Problems: Numerical Solution and Applications

The numerical approximation of several important scientific and engineering problems leads to block-structured indefinite linear systems or saddle point systems. These problems arise in systems of PDEs with conservation laws, in constrained optimization problems, and in generalized least squares problems, and their efficient numerical solution is the subject of much research. The successful design of robust, scalable, and efficient preconditioners is intimately connected with an understanding of the structure of the resulting block matrix system. Effective preconditioners are often based on an approximate block decomposition of the system that derives from a careful consideration of the spectral properties of the component block operators and the Schur complement operators. Through this purely algebraic view of preconditioning, a simplified system of block component equations is developed that encodes a specific "physics based" decomposition. Recent progress based on these ideas has led to the construction of a number of effective preconditioners with optimal or nearly optimal convergence rates for several applications. However, to compute accurate solutions to saddle point problems at a reasonable cost has proved difficult. As a consequence, a significant effort has been devoted to define proper formulations, discretizations, and fast solution methods for discretized saddle point problems and their generalizations.

This special volume of ETNA brings together papers on the continuous and discrete formulation of saddle point problems from several areas of computational science, both for specific and general problems, and on efficient (parallel) solution techniques for the resulting systems of equations. The editors hope that the present volume will be useful both to researchers dealing with applications that give rise to saddle point problems and to developers of effective solution techniques for the resulting equations.

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