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LARGE SCALE EIGENVALUE PROBLEMS

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ABSTRACT

Many modern applications lead to linear eigenvalue problems for matrices the order of which easily exceeds the order of a million and several hundred or thousand eigenpairs are often required. Problems of this type arise for instance in the dynamic analysis of structures, the stability analysis in plasma physics, the density functional approach in chemical physics, and the design of resonant cavities of particle accelerators, to name just a few. These problems are so big that the involved matrices can not be factorized, and that standard shift-and-invert Lanczos or Arnoldi methods are not suitable solution methods. Speakers of the minisymposium will discuss ways to overcome this problem presenting iterative projection methods (where approximations to the wanted eigenpairs are obtained from projections to subspaces of small dimension which are expanded in the course of the algorithm) of Lanczos or Arnoldi type, versions of Davidson and Jacobi-Davidson expansions, and locally optimal preconditioned conjugate gradient algorithms.

Further presentations of this minisymposium reflect sparse nonlinear eigenvalue problems. Methods of this type arise in a wide variety of applications like micro electromechanical systems, vibrations of fluid-solid structures, the numerical simulation of semiconductor nanostructures, and stability of time-delay systems, e.g. Systematic new linearization approaches for quadratic, and more generally polynomial eigenvalue problems are discussed that preserve internal structures such as eigenvalue symmetries. Minmax characterizations of real eigenvalues for some classes of problems are exploited for determining some extreme eigenpairs of large and sparse symmetric eigenproblems with applications to the Schroedinger equation depending rationally on the eigenparameter and to regularized total least squares problems. Generalizations of iterative projection methods to nonlinear eigenproblems are studied and applied to problems arising from finite element analysis of resonant frequencies of waveguide loaded cavaties.