

Preconditioning for Iterative Methods

- Convergence rate of iterative solvers strongly depends on the spectral properties (eigenvalue distribution) of the coefficient matrix \mathbf{A} .
- A preconditioner \mathbf{M} transforms the linear system into one with more favorable spectral properties
 - In "ill-conditioned" problems, "condition number" (ratio of max/min eigenvalue if \mathbf{A} is symmetric) is large.
 - \mathbf{M} transforms original equation $\mathbf{Ax}=\mathbf{b}$ into $\mathbf{A}'\mathbf{x}=\mathbf{b}'$ where $\mathbf{A}'=\mathbf{M}^{-1}\mathbf{A}$, $\mathbf{b}'=\mathbf{M}^{-1}\mathbf{b}$
- ILU (Incomplete LU Factorization) or IC (Incomplete Cholesky Factorization) are well-known preconditioners.

Preconditioning Iterative Methods

Yi-Tong Ma



Preconditioning Iterative Methods:

Iterative Methods and Preconditioning for Large and Sparse Linear Systems with Applications Daniele Bertaccini, Fabio Durastante, 2018-02-19 This book describes in a basic way the most useful and effective iterative solvers and appropriate preconditioning techniques for some of the most important classes of large and sparse linear systems The solution of large and sparse linear systems is the most time consuming part for most of the scientific computing simulations Indeed mathematical models become more and more accurate by including a greater volume of data but this requires the solution of larger and harder algebraic systems In recent years research has focused on the efficient solution of large sparse and or structured systems generated by the discretization of numerical models by using iterative solvers

A Survey of Preconditioned Iterative Methods Are Magnus Bruaset, 2018-12-13 The problem of solving large sparse linear systems of algebraic equations is vital in scientific computing even for applications originating from quite different fields A Survey of Preconditioned Iterative Methods presents an up to date overview of iterative methods for numerical solution of such systems Typically the methods considered are w

Preconditioning Methods David J. Evans, 1983-01-01

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Preconditioned Iterative Methods David J. Evans, 1994 Precondition Gradient Methods emerged in the early 1970s as the most impressive algorithm for the large sparse definite problems The method has gained large acceptance throughout the world since then and undergone rapid development The method has been generalized to non symmetric and indefinite problems domain decomposition eigenvalue problems and many other application areas The analysis of the preconditioning strategy is both a mathematically fascinating and complex topic Since the topic appears to be expanding in importance it was felt opportune to present this volume containing papers on preconditioned iterative methods Incomplete Factorisation and SSOR preconditioning and the Preconditioned Conjugate Gradient Method covering symmetric and non symmetric systems on computers vector and parallel for finite element and computational fluid dynamic applications This volume serves as a useful companion volume to the previously published *Preconditioning Methods Theory and Application*

Preconditioned Iterative Methods for Indefinite Symmetric Toeplitz Systems Paul Concus, Paul E. Saylor, 1989

Iterative Methods and Preconditioners for Systems of Linear Equations Gabriele Ciaramella, Martin J. Gander, 2022-02-08 Iterative methods use successive approximations to obtain more accurate solutions This book gives an introduction to iterative methods and preconditioning for solving discretized elliptic partial differential equations and optimal control problems governed by the Laplace equation for which the use of matrix free procedures is crucial All methods are explained and analyzed starting from the historical ideas of the inventors which are

often quoted from their seminal works *Iterative Methods and Preconditioners for Systems of Linear Equations* grew out of a set of lecture notes that were improved and enriched over time resulting in a clear focus for the teaching methodology which derives complete convergence estimates for all methods illustrates and provides MATLAB codes for all methods and studies and tests all preconditioners first as stationary iterative solvers This textbook is appropriate for undergraduate and graduate students who want an overview or deeper understanding of iterative methods Its focus on both analysis and numerical experiments allows the material to be taught with very little preparation since all the arguments are self contained and makes it appropriate for self study as well It can be used in courses on iterative methods Krylov methods and preconditioners and numerical optimal control Scientists and engineers interested in new topics and applications will also find the text useful

Preconditioning of Iterative Methods for Linearised Or Linear Systems William Michael Connolley,1989 *Iterative Methods in Scientific Computing and Their Applications* Raymond Chan,1997-04 Because of the rapid evolution of the development of this field as well as the fact that iterative methods are not often developed in a generic form for general applications there is a lack of published materials that treat the topic properly and fully These lectures from the Winter School on Iterative Methods in Scientific Computing and their Applications aims to bridge such a gap in the literature

Mechanical Properties of Materials and Information Technology Hong Hua Tan,2011-09-21 Selected peer reviewed papers from the 2011 International Conference on Mechanical Properties of Materials and Information Technology ICMPMIT 2011 September 10 11 2011 Chongqing China **Practical Iterative Methods for Large Scale Computations** Daniel L. Boley,1989 **A Subspace Preconditioning Algorithm for Eigenvector/Eigenvalue Computation** James H. Bramble,1995 *A Family of Preconditioned Iterative Solvers for Sparse Linear Systems* Ulrike Meier Yang,University of Illinois at Urbana-Champaign. Department of Computer Science,1995 Abstract Based on the relationship between the family of Broyden methods and the EN method a new family of iterative methods the family of EN like methods is developed and analyzed These methods are shown to be related to a variety of other known methods which comprise the Broyden methods GCR GMRES Newton s method for approximating the inverse and a combination of a Galerkin step followed by a step of Richardson s method Scaling invariant versions and implementations of higher efficiency are developed and their complexity is examined The convergence of the new methods as well as their restarted and truncated versions are examined Various convergence results are derived which include termination within a finite number of steps and estimates for residuals and errors The methods are also shown to be suitable in the context of inner outer iteration schemes and for two of the methods orthogonality preserving inner outer iteration schemes are developed Adaptive versions which are a combination of truncated and restarted versions and which automatically increase the size of the Krylov subspace are included in the software package PARASPAR which achieves robustness by reevaluating a parametrized preconditioner whenever poor convergence or instability is encountered We present numerical experiments that demonstrate the efficiency of several

members of this new family in comparison with other known methods in the context of PARASPAR and in the context of inner outer iteration schemes The experiments show that even though methods like CGS and BiCGSTAB may converge faster for many problems EN like methods are in general more robust since like GMRES they have the option of increasing the size of the Krylov subspace Additionally they often require less memory than GMRES or ORTHOMIN They are also very suitable as iterative solvers inside PARASPAR since they evaluate without additional cost parameters that estimate the quality of the preconditioner Some EN like methods also show drastic divergence when applied to an ill conditioned problem Consequently it is possible to quickly recongnize when to reevaluate sic the preconditioner Finally nonlinear EN like methods are developed and their convergence behavior is investigated Accelerating Iterative Methods by Inducing Sparsity in the Residual Vector Todd Kevin Goehring,1999 **Preconditioned Minimal Residual Methods for Chebyshev Equations**

,1983 **An Overview of Preconditioned Iterative Methods for Sparse Matrix Equations** F. W. Letniowski,University of Waterloo. Dept. of Computer Science,1989 Abstract A basic overview is provided toward the solution of large sparse matrix equations $Ax = b$ using preconditioned accelerated iterative methods The conjugate gradient method of acceleration for symmetric matrices is discussed in some detail followed by a description of algorithms for nonsymmetric matrices ORTHOMIN GMRES bi conjugate gradients and conjugate gradients squared Methods of preconditioning are discussed with emphasis on DKR factorisations modified incomplete LU factorisations and reduced systems red black ordering as well as block preconditioning and other re ordering methods Some applications of these methods are given at the end

Preconditioned Mixed Spectral Element Methods for Elasticity and Stokes Problems Luca F. Pavarino,Institute for Computer Applications in Science and Engineering,1996 *Parameter-Free Iterative Linear Solvers* Rüdiger Weiss,1996-08-15 This book presents a unifying theoretical framework for iterative solvers for linear systems The focus is on parameter free methods i e methods that can be applied without a priori knowledge of inner properties of the systems Despite the generality of the approach convergence estimates and geometrical properties can be derived State of the art solvers are surveyed and classified Many new relations between these methods are furnished leading to a deeper insight Existing gaps in the theory are pointed out and some visions for the design of more efficient and robust solvers are given A valuation of established methods based on the theoretical results and on numerical tests is given Recipes for the application of particular techniques are derived The criteria are efficiency robustness and the possibility of parallelization This book has a triple aim to simplify the analysis by a unified theory to survey and valuate state of the art solvers and to give an introduction to iterative solvers for non experts in the field **Preconditioned Eigensolvers** Andrew V. Knyazev,1999

Preconditioning of Nonconforming Finite Element Methods for Second-order Elliptic Boundary Value Problems Sze-Ping Wong,1992

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