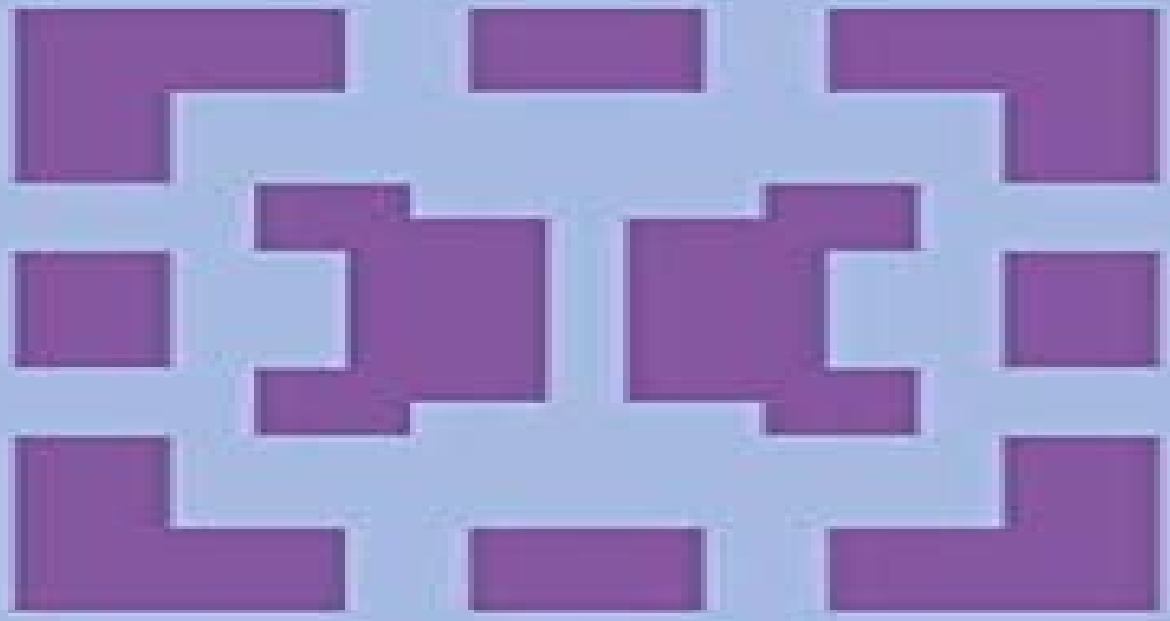
Mathematics and Its Applications

Marián Vajteršic

Algorithms for Elliptic Problems

Efficient Sequential and Parallel Solvers



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Some Efficient Sequential And Parallel Elliptic Solvers

Timothy J. Barth,Tony Chan,Robert Haimes

Some Efficient Sequential And Parallel Elliptic Solvers:

Algorithms for Elliptic Problems Marián Vajtersic,2013-03-09 This volume deals with problems of modern effective algorithms for the numerical solution of the most frequently occurring elliptic partial differential equations From the point of view of implementation attention is paid to algorithms for both classical sequential and parallel computer systems The first two chapters are devoted to fast algorithms for solving the Poisson and biharmonic equation In the third chapter parallel algorithms for model parallel computer systems of the SIMD and MIMD types are described The implementation aspects of parallel algorithms for solving model elliptic boundary value problems are outlined for systems with matrix pipeline and multiprocessor parallel computer architectures A modern and popular multigrid computational principle which offers a good opportunity for a parallel realization is described in the next chapter More parallel variants based in this idea are presented whereby methods and assignments strategies for hypercube systems are treated in more detail The last chapter presents VLSI designs for solving special tridiagonal linear systems of equations arising from finite difference approximations of elliptic problems For researchers interested in the development and application of fast algorithms for solving elliptic partial differential equations using advanced computer systems **A Tutorial on Elliptic PDE Solvers and Their Parallelization** Craig C. Douglas,Gundolf Haase,Ulrich Langer,2003-01-01 A Tutorial on Elliptic PDE Solvers and Their Parallelization is a valuable aid for learning about the possible errors and bottlenecks in parallel computing One of the highlights of the tutorial is that the course material can run on a laptop not just on a parallel computer or cluster of PCs thus allowing readers to experience their first successes in parallel computing in a relatively short amount of time This tutorial is intended for advanced undergraduate and graduate students in computational sciences and engineering however it may also be helpful to professionals who use PDE based parallel computer simulations in the field **Encyclopedia of Parallel Computing** David Padua,2011-09-08 Containing over 300 entries in an A Z format the Encyclopedia of Parallel Computing provides easy intuitive access to relevant information for professionals and researchers seeking access to any aspect within the broad field of parallel computing Topics for this comprehensive reference were selected written and peer reviewed by an international pool of distinguished researchers in the field The Encyclopedia is broad in scope covering machine organization programming languages algorithms and applications Within each area concepts designs and specific implementations are presented The highly structured essays in this work comprise synonyms a definition and discussion of the topic bibliographies and links to related literature Extensive cross references to other entries within the Encyclopedia support efficient user friendly searchers for immediate access to useful information Key concepts presented in the Encyclopedia of Parallel Computing include laws and metrics specific numerical and non numerical algorithms asynchronous algorithms libraries of subroutines benchmark suites applications sequential consistency and cache coherency machine classes such as clusters shared memory multiprocessors special purpose machines and dataflow machines specific machines such as Cray

supercomputers IBM s cell processor and Intel s multicore machines race detection and auto parallelization parallel programming languages synchronization primitives collective operations message passing libraries checkpointing and operating systems Topics covered Speedup Efficiency Isoefficiency Redundancy Amdahls law Computer Architecture Concepts Parallel Machine Designs Benmarks Parallel Programming concepts design Algorithms Parallel applications This authoritative reference will be published in two formats print and online The online edition features hyperlinks to cross references and to additional significant research Related Subjects supercomputing high performance computing distributed computing **Numerical Methods for Black-Box Software in Computational Continuum Mechanics** Sergey I. Martynenko,2023-10-24 The organization of the material is presented as follows This introductory chapter I represents a theoretical analysis of the computational algorithms for a numerical solution of the basic equations in continuum mechanics In this chapter the general requirements for computational grids discretization and iterative methods for black box software are examined Finally a concept of a two grid algorithm for de coupled solving multidimensional non linear initial boundary value problems in continuum mechanics multiphysics simulation in complex domains is presented Chapter II contains descriptions of the sequential Robust Multigrid Technique which is developed as a general purpose solver in black box codes This chapter presents the main components of the Robust Multigrid Technique RMT used in the two grid algorithm Chapter I to compute the auxiliary structured grid correction This includes the generation of multigrid structures computation of index mapping and integral evaluation Finite volume discretization on the multigrid structures will be explained by studying a 1D linear model problem In addition the algorithmic complexity of RMT and black box optimization of the problem dependent components of RMT are analysed Chapter III provides a description of parallel RMT This chapter introduces parallel RMT based algorithms for solving the boundary value problems and initial boundary value problems in unified manner Section 1 presents a comparative analysis of the parallel RMT and the sequential V cycle Sections 2 and 3 present a geometric and an algebraic parallelism of RMT i e parallelization of the smoothing iterations on the coarse and the levels A parallel multigrid cycle will be considered in Section 4 A parallel RMT for the time dependent problems is given in Section 5 Finally the basic properties of parallel RMT will be summarized in Section 6 Theoretical aspects of the used algorithms for solving multidimensional problems are discussed in Chapters IV This chapter contains the theoretical aspects of the algorithms used for the numerical solving of the resulting system of linear algebraic equations obtained from discrete multidimensional initial boundary value problems Parallelism in Matrix Computations Efstratios Gallopoulos,Bernard Philippe,Ahmed H. Sameh,2015-07-25 This book is primarily intended as a research monograph that could also be used in graduate courses for the design of parallel algorithms in matrix computations It assumes general but not extensive knowledge of numerical linear algebra parallel architectures and parallel programming paradigms The book consists of four parts I Basics II Dense and Special Matrix Computations III Sparse Matrix Computations and IV Matrix functions and characteristics Part I deals with

parallel programming paradigms and fundamental kernels including reordering schemes for sparse matrices Part II is devoted to dense matrix computations such as parallel algorithms for solving linear systems linear least squares the symmetric algebraic eigenvalue problem and the singular value decomposition It also deals with the development of parallel algorithms for special linear systems such as banded Vandermonde Toeplitz and block Toeplitz systems Part III addresses sparse matrix computations a the development of parallel iterative linear system solvers with emphasis on scalable preconditioners b parallel schemes for obtaining a few of the extreme eigenpairs or those contained in a given interval in the spectrum of a standard or generalized symmetric eigenvalue problem and c parallel methods for computing a few of the extreme singular triplets Part IV focuses on the development of parallel algorithms for matrix functions and special characteristics such as the matrix pseudospectrum and the determinant The book also reviews the theoretical and practical background necessary when designing these algorithms and includes an extensive bibliography that will be useful to researchers and students alike The book brings together many existing algorithms for the fundamental matrix computations that have a proven track record of efficient implementation in terms of data locality and data transfer on state of the art systems as well as several algorithms that are presented for the first time focusing on the opportunities for parallelism and algorithm robustness Parallel Solution of Partial Differential Equations Mitchell Barry Luskin,2000 The papers in this volume are based on lectures given at the IMA workshop on the Parallel Solution of PDE during June 9 13 1997 The numerical solution of partial differential equations has been of major importance to the development of many technologies and has been the target of much of the development of parallel computer hardware and software Parallel computer offers the promise of greatly increased performance and the routine calculation of previously intractable problems This volume contains papers on the development and assessment of new approximation and solution techniques that can take advantage of parallel computers It will be of interest to applied mathematicians computer scientists and engineers concerned with investigating the state of the art and future directions in numerical computing Topics include domain decomposition methods parallel multi grid methods front tracking methods sparse matrix techniques adaptive methods fictitious domain methods and novel time and space discretizations Applications discussed include fluid dynamics radiative transfer solid mechanics and semiconductor simulation Parallel Computational Fluid Dynamics 2000 C.B. Jenssen,T. Kvamdal,H.I. Andersson,B. Pettersen,P. Fox,N. Satofuka,A. Ecer,Jacques Periaux,2001-04-27 Parallel CFD 2000 the Twelfth in an International series of meetings featuring computational fluid dynamics research on parallel computers was held May 22 25 2000 in Trondheim Norway Following the trend of the past conferences areas such as numerical schemes and algorithms tools and environments load balancing as well as interdisciplinary topics and various kinds of industrial applications were all well represented in the work presented In addition for the first time in the Parallel CFD conference series the organizing committee chose to draw special attention to certain subject areas by organizing a number of special sessions We feel the emphasis of the papers

presented at the conference reflect the direction of the research within parallel CFD at the beginning of the new millennium It seems to be a clear tendency towards increased industrial exploitation of parallel CFD Several presentations also demonstrated how new insight is being achieved from complex simulations and how powerful parallel computers now make it possible to use CFD within a broader interdisciplinary setting Obviously successful application of parallel CFD still rests on the underlying fundamental principles Therefore numerical algorithms development tools and parallelization techniques are still as important as when parallel CFD was in is infancy Furthermore the novel concepts of affordable parallel computing as well as metacomputing show that exciting developments are still taking place As is often pointed out however the real power of parallel CFD comes from the combination of all the disciplines involved Physics mathematics and computer science This is probably one of the principal reasons for the continued popularity of the Parallel CFD Conferences series as well as the inspiration behind much of the excellent work carried out on the subject We hope that the papers in this book both on an individual basis and as a whole will contribute to that inspiration Further details of Parallel CFD 99 as well as other conferences in this series are available at http www parcfd org **Multiscale and Multiresolution Methods** Timothy J. Barth,Tony Chan,Robert Haimes,2012-12-06 Many computionally challenging problems omnipresent in science and engineering exhibit multiscale phenomena so that the task of computing or even representing all scales of action is computationally very expensive unless the multiscale nature of these problems is exploited in a fundamental way Some diverse examples of practical interest include the computation of fluid turbulence structural analysis of composite materials terabyte data mining image processing and a multitude of others This book consists of both invited and contributed articles which address many facets of efficient multiscale representation and scientific computation from varied viewpoints such as hierarchical data representations multilevel algorithms algebraic homogeni zation and others This book should be of particular interest to readers interested in recent and emerging trends in multiscale and multiresolution computation with application to a wide range of practical problems *Mathematical Reviews* ,2005 Scientific Computing in Object-Oriented Parallel Environments Yutaka Ishikawa,1997-11-19 Content Description Includes bibliographical references and index Proceedings of the Seventh SIAM Conference on Parallel Processing for Scientific Computing David H. Bailey,1995-01-01 Proceedings Parallel Computing *Parallel Processing for Scientific Computing* G. Rodrigue,Society for Industrial and Applied Mathematics,1989-01-01 Mathematics of Computing Parallelism *Multigrid Methods V* Wolfgang Hackbusch,Gabriel Wittum,2012-12-06 This volume contains a selection from the papers presented at the Fifth European Multigrid Conference held in Stuttgart October 1996 All contributions were carefully refereed The conference was organized by the Institute for Computer Applications ICA of the University of Stuttgart in cooperation with the GAMM Committee for Scientific Computing SFB 359 and 404 and the research network WiR Ba W The list of topics contained lectures on Multigrid Methods robustness adaptivity wavelets parallelization application in computational fluid dynamics porous media flow

optimisation and computational mechanics A considerable part of the talks focused on algebraic multigrid methods

Forthcoming Books Rose Arny,1992 **Large-Scale Scientific Computing** Svetozar Margenov,Jerzy Wasniewski,Plamen Yalamov,2001-12-12 Thepurposeoftheconferencewastobringtogetherscientistsworkingwith largecomputationalproblemsinindustry andspecialistsinthe eldofnume calanalysis methodsande cientexploitationofmodernhigh speedcomputers Someclassesofmethodsappearagainandagaininthenumericaltreatmentof problemsfromdi erent eldsofscienceandengineering Theaimofthisconf encewastoselectsomeofthesenumericalmethodsandplanfurtherexperiments onseveraltypesofparallelcomputers Thekeylecturesreviewedthemostimp tantnumericalalgorithmsandscienti capplicationsonparallelcomputers The invited speakers included university and practical engineers from industry as wellasappliedmathematicians numericalanalysts andcomputerexperts Solution of Partial Differential Equations on Vector and Parallel Computers James M. Ortega,Robert G. Voigt,1985-09-01 Mathematics of Computing Parallelism **An Efficient Parallel Multigrid Solver for 3-D Convection-dominated Problems** Ignacio M. Llorente,2000 Multigrid algorithms are known to be highly efficient in solving systems of elliptic equations However standard multi grid algorithms fail to achieve optimal grid independent convergence rates in solving non elliptic problems In many practical cases the non elliptic part of a problem is represented by the convection operator Downstream marching when it is viable is the simplest and most efficient way to solve this operator However in a parallel setting the sequential nature of marching degrades the efficiency of the algorithm The aim of this report is to present evaluate and analyze an alternative highly parallel multi grid method for 3 D convection dominated problems This method employs semi coarsening a four color plane implicit smoother and discretization rules allowing the same cross characteristic interactions on all the grids involved to be maintained The resulting multigrid solver exhibits a fast grid independent convergence rate for solving the convection diffusion operator on cell centered grids with stretching The load imbalance below the critical level is the main source of inefficiency in its parallel implementation A hybrid smoother that degrades the convergence properties of the method but improves its granularity has been found to be the best choice in a parallel setting The numerical and parallel properties of the multi grid algorithm with the four color and hybrid smoothers are studied on SGI Origin 2000 and Cray T3E systems **Proceedings of the Eighth International Colloquium on Differential Equations, Plovdiv, Bulgaria, 18–23 August, 1997** D. Bainov,2020-05-18 No detailed description available for Proceedings of the Eighth International Colloquium on Differential Equations Plovdiv Bulgaria 18 23 August 1997

Parallel Multilevel Methods Gerhard Zumbusch,2012-12-06 Numerical simulation promises new insight in science and engineering In ad dition to the traditional ways to perform research in science that is laboratory experiments and theoretical work a third way is being established numerical simulation It is based on both mathematical models and experiments con ducted on a computer The discipline of scientific computing combines all aspects of numerical simulation The typical

approach in scientific computing includes modelling numerics and simulation see Figure l Quite a lot of phenomena in science and engineering can be modelled by partial differential equations PDEs In order to produce accurate results complex models and high resolution simulations are needed While it is easy to increase the precision of a simulation the computational cost of doing so is often prohibitive Highly efficient simulation methods are needed to overcome this problem This includes three building blocks for computational efficiency discretisation solver and computer Adaptive mesh refinement high order and sparse grid methods lead to discretisations of partial differential equations with a low number of degrees of freedom Multilevel iterative solvers decrease the amount of work per degree of freedom for the solution of discretised equation systems Massively parallel computers increase the computational power available for a single simulation

Parallel Computing Roman Trobec,Marián Vajteršic,Peter Zinterhof,2009-06-18 The use of parallel programming and architectures is essential for simulating and solving problems in modern computational practice There has been rapid progress in microprocessor architecture interconnection technology and software devel ment which are in uencing directly the rapid growth of parallel and distributed computing However in order to make these bene ts usable in practice this dev opment must be accompanied by progress in the design analysis and application aspects of parallel algorithms In particular new approaches from parallel num ics are important for solving complex computational problems on parallel and or distributed systems The contributions to this book are focused on topics most concerned in the trends of today s parallel computing These range from parallel algorithmics progr ming tools network computing to future parallel computing Particular attention is paid to parallel numerics linear algebra differential equations numerical integ tion number theory and their applications in computer simulations which together form the kernel of the monograph We expect that the book will be of interest to scientists working on parallel computing doctoral students teachers engineers and mathematicians dealing with numerical applications and computer simulations of natural phenomena

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