

ABS ALGORITHMS FOR LINEAR EQUATIONS AND ABSPACK

E. SPEDICATO(*) - Z. XIA(**) - E. BODON(***) - A. DEL POPOLO(†)

ABSTRACT - We present the main results obtained during a research on ABS methods in the framework of the project *Analisi Numerica e Matematica Computazionale*.

1. - The ABS algorithms

ABS algorithms were introduced by Abaffy, Broyden and Spedicato (1984), to solve linear equations first in the form of the *basic ABS class*, later generalized as the *scaled ABS class* and applied to linear least squares, nonlinear equations and optimization problems, see e.g. the monographs by Abaffy and Spedicato (1989) and Zhang, Xia and Feng (1999), or the bibliography by Nicolai and Spedicato (1997) listing over 300 ABS papers. In this paper we consider some new results obtained in the framework of project *Analisi Numerica e Matematica Computazionale*, including the performance of several codes of ABSPACK, a FORTRAN package under development.

For later reference, we recall the scaled ABS algorithm for solving the following determined or underdetermined linear system, where $\text{rank}(A)$ is arbitrary and $A^T = (a_1, \dots, a_m)$

$$Ax = b \quad x \in R^n, \quad b \in R^m, \quad m \leq n \quad (1)$$

or

$$a_i^T x - b_i = 0, \quad i = 1, \dots, m \quad (2)$$

The scaled ABS algorithm

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Abs Projection Algorithms Mathematical Techniques For Linear And Nonlinear Equations

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Abs Projection Algorithms Mathematical Techniques For Linear And Nonlinear Equations:

ABS Projection Algorithms Jozsef Abaffy, E. Spedicato, 1989 Nonlinear Equations and Optimisation L.T. Watson, J.A. Ford, M. Bartholomew-Biggs, 2001-03-14 homepage sac.cam.ac.uk/na2000/index.html Volume Set now available at special set price In one of the papers in this collection the remark that nothing at all takes place in the universe in which some rule of maximum of minimum does not appear is attributed to no less an authority than Euler Simplifying the syntax a little we might paraphrase this as Everything is an optimization problem While this might be something of an overstatement the element of exaggeration is certainly reduced if we consider the extended form Everything is an optimization problem or a system of equations This observation even if only partly true stands as a fitting testimonial to the importance of the work covered by this volume Since the 1960s much effort has gone into the development and application of numerical algorithms for solving problems in the two areas of optimization and systems of equations As a result many different ideas have been proposed for dealing efficiently with for example severe nonlinearities and or very large numbers of variables Libraries of powerful software now embody the most successful of these ideas and one objective of this volume is to assist potential users in choosing appropriate software for the problems they need to solve More generally however these collected review articles are intended to provide both researchers and practitioners with snapshots of the state of the art with regard to algorithms for particular classes of problem These snapshots are meant to have the virtues of immediacy through the inclusion of very recent ideas but they also have sufficient depth of field to show how ideas have developed and how today's research questions have grown out of previous solution attempts The most efficient methods for local optimization both unconstrained and constrained are still derived from the classical Newton approach As well as dealing in depth with the various classical or neo classical approaches the selection of papers on optimization in this volume ensures that newer ideas are also well represented Solving nonlinear algebraic systems of equations is closely related to optimization The two are not completely equivalent however and usually something is lost in the translation Algorithms for nonlinear equations can be roughly classified as locally convergent or globally convergent The characterization is not perfect Locally convergent algorithms include Newton's method modern quasi Newton variants of Newton's method and trust region methods All of these approaches are well represented in this volume *Computer Algorithms for Solving Linear Algebraic Equations* Emilio Spedicato, 2012-12-06 The NATO Advanced Study Institute on Computer algorithms for solving linear algebraic equations the state of the art was held September 9-21 1990 at Il Ciocco Barga Italy It was attended by 68 students among them many well known specialists in related fields from the following countries Belgium Brazil Canada Czechoslovakia Denmark France Germany Greece Holland Hungary Italy Portugal Spain Turkey UK USA USSR Yugoslavia Solving linear equations is a fundamental task in most of computational mathematics Linear systems which are now encountered in practice may be of very large dimension and their solution can still be a challenge in terms of the requirements of accuracy or reasonable

computational time With the advent of supercomputers with vector and parallel features algorithms which were previously formulated in a framework of sequential operations often need a completely new formulation and algorithms that were not recommended in a sequential framework may become the best choice The aim of the ASI was to present the state of the art in this field While not all important aspects could be covered for instance there is no presentation of methods using interval arithmetic or symbolic computation we believe that most important topics were considered many of them by leading specialists who have contributed substantially to the developments in these fields

Computational Solution of Nonlinear Systems of Equations Eugene L. Allgower, Kurt Georg, 1990-04-03 Nonlinear equations arise in essentially every branch of modern science engineering and mathematics However in only a very few special cases is it possible to obtain useful solutions to nonlinear equations via analytical calculations As a result many scientists resort to computational methods This book contains the proceedings of the Joint AMS SIAM Summer Seminar Computational Solution of Nonlinear Systems of Equations held in July 1988 at Colorado State University The aim of the book is to give a wide ranging survey of essentially all of the methods which comprise currently active areas of research in the computational solution of systems of nonlinear equations A number of entry level survey papers were solicited and a series of test problems has been collected in an appendix Most of the articles are accessible to students who have had a course in numerical analysis

Nonlinear Optimization and Applications Gianni Pillo, F. Giannessi, 2013-11-11 This volume contains the edited texts of the lectures presented at the workshop on Nonlinear Optimization Theory and Applications held in Erice at the G Stampacchia School of Mathematics of the E Majorana International Centre for Scientific Culture June 13 21 1995 The meeting was conceived to review and discuss recent advances and promising research trends concerning theory algorithms and innovative applications in the field This is a field of mathematics which is providing viable of Nonlinear Optimization tools in engineering in economics and in other applied sciences and which is giving a great contribution also in the solution of the more practiced linear optimization problems The meeting was attended by approximately 70 people from 18 countries Besides the lectures several formal and informal discussions took place The result was a broad exposure providing a wide and deep understanding of the present research achievements in the field We wish to express our appreciation for the active contributions of all the participants in the meeting Our gratitude is due to the Ettore Majorana Center in Erice which offered its facilities and stimulating environment its staff was certainly instrumental for the success of the meeting Our gratitude is also due to Francisco Facchinei and Massimo Roma for the time spent in the organization of the workshop and to Giuliana Cai for the careful typesetting of this volume

Iterative Solution Methods Owe Axelsson, 1996-03-29 This book deals primarily with the numerical solution of linear systems of equations by iterative methods The first part of the book is intended to serve as a textbook for a numerical linear algebra course The material assumes the reader has a basic knowledge of linear algebra such as set theory and matrix algebra however it is demanding for students who are not afraid of theory To assist the reader the

more difficult passages have been marked the definitions for each chapter are collected at the beginning of the chapter and numerous exercises are included throughout the text The second part of the book serves as a monograph introducing recent results in the iterative solution of linear systems mainly using preconditioned conjugate gradient methods This book should be a valuable resource for students and researchers alike wishing to learn more about iterative methods

Computation and Applied Mathematics, 1994 *Encyclopedia of Optimization* Christodoulos A. Floudas, Panos M. Pardalos, 2008-09-04 The goal of the Encyclopedia of Optimization is to introduce the reader to a complete set of topics that show the spectrum of research the richness of ideas and the breadth of applications that has come from this field The second edition builds on the success of the former edition with more than 150 completely new entries designed to ensure that the reference addresses recent areas where optimization theories and techniques have advanced Particularly heavy attention resulted in health science and transportation with entries such as Algorithms for Genomics Optimization and Radiotherapy Treatment Design and Crew Scheduling

Algorithms for Continuous Optimization E. Spedicato, 2012-12-06 The NATO Advanced Study Institute on Algorithms for continuous optimization the state of the art was held September 5-18 1993 at Il Ciocco Barga Italy It was attended by 75 students among them many well known specialists in optimization from the following countries Belgium Brasil Canada China Czech Republic France Germany Greece Hungary Italy Poland Portugal Rumania Spain Turkey UK USA Venezuela The lectures were given by 17 well known specialists in the field from Brasil China Germany Italy Portugal Russia Sweden UK USA Solving continuous optimization problems is a fundamental task in computational mathematics for applications in areas of engineering economics chemistry biology and so on Most real problems are nonlinear and can be of quite large size Developing efficient algorithms for continuous optimization has been an important field of research in the last 30 years with much additional impetus provided in the last decade by the availability of very fast and parallel computers Techniques like the simplex method that were already considered fully developed thirty years ago have been thoroughly revised and enormously improved The aim of this ASI was to present the state of the art in this field While not all important aspects could be covered in the fifty hours of lectures for instance multiobjective optimization had to be skipped we believe that most important topics were presented many of them by scientists who greatly contributed to their development

Numerical Analysis and Optimization Mehiddin Al-Baali, Lucio Grandinetti, Anton Purnama, 2015-07-16 Presenting the latest findings in the field of numerical analysis and optimization this volume balances pure research with practical applications of the subject Accompanied by detailed tables figures and examinations of useful software tools this volume will equip the reader to perform detailed and layered analysis of complex datasets Many real world complex problems can be formulated as optimization tasks Such problems can be characterized as large scale unconstrained constrained non convex non differentiable and discontinuous and therefore require adequate computational methods algorithms and software tools These same tools are often employed by researchers working in current IT hot topics such as big data optimization and

other complex numerical algorithms on the cloud devising special techniques for supercomputing systems The list of topics covered include but are not limited to numerical analysis numerical optimization numerical linear algebra numerical differential equations optimal control approximation theory applied mathematics algorithms and software developments derivative free optimization methods and programming models The volume also examines challenging applications to various types of computational optimization methods which usually occur in statistics econometrics finance physics medicine biology engineering and industrial sciences

Recent Trends in Numerical Analysis D. Trigiante, 2000 The contributions for this volume dedicated to honour the 65th birthday of Professor I Galligani have been numerous and cover a wide range of topics of the current Numerical Analysis and of its applications

Computation and Applied Mathematics, 1994 Parallel Computing Technologies Victor Malyshev, 1997-08-06 This book constitutes the refereed proceedings of the Fourth International Conference on Parallel Computing Technologies PaCT 97 held in Yaroslavl Russia in September 1997 The volume presents a total of 54 contributions 21 full papers 20 short papers 10 posters and three tutorials All papers were selected for inclusion in the proceedings from numerous submissions on the basis of three independent reviews The volume covers all current topics in parallel processing it is divided into sections on theory software hardware and architecture applications posters and tutorials

Projectors and Projection Methods Aurél Galántai, 2013-12-11 The projectors are considered as simple but important type of matrices and operators Their basic theory can be found in many books among which Halmas 177 178 are of particular significance The projectors or projections became an active research area in the last two decades due to ideas generated from linear algebra statistics and various areas of algorithmic mathematics There has also grown up a great and increasing number of projection methods for different purposes The aim of this book is to give a unified survey on projectors and projection methods including the most recent results The words projector projection and idempotent are used as synonyms although the word projection is more common We assume that the reader is familiar with linear algebra and mathematical analysis at a bachelor level The first chapter includes supplements from linear algebra and matrix analysis that are not incorporated in the standard courses The second and the last chapter include the theory of projectors Four chapters are devoted to projection methods for solving linear and non linear systems of algebraic equations and convex optimization problems

Sixth International Vilnius Conference on Probability Theory and Mathematical Statistics: A-L, 1993

Advances in Mathematics Research Gabriel Oyibo, 2003-09-10 Mathematics has been behind many of humanity's most significant advances in fields as varied as genome sequencing medical science space exploration and computer technology But those breakthroughs were yesterday Where will mathematicians lead us tomorrow and can we help to shape that destiny This book assembles carefully selected articles highlighting and explaining cutting edge research and scholarship in mathematics

Numerical Methods of Nonlinear Programming and Their Implementations Claus Richter, Horst Hollatz, Diethard Pallaschke, 1991

Computation and Applied Mathematics, 1994

Iterative Methods

for Solving Nonlinear Equations and Systems Juan R. Torregrosa, Alicia Cordero, Fazlollah Soleymani, 2019-12-06 Solving nonlinear equations in Banach spaces real or complex nonlinear equations nonlinear systems and nonlinear matrix equations among others is a non trivial task that involves many areas of science and technology Usually the solution is not directly affordable and require an approach using iterative algorithms This Special Issue focuses mainly on the design analysis of convergence and stability of new schemes for solving nonlinear problems and their application to practical problems Included papers study the following topics Methods for finding simple or multiple roots either with or without derivatives iterative methods for approximating different generalized inverses real or complex dynamics associated to the rational functions resulting from the application of an iterative method on a polynomial Additionally the analysis of the convergence has been carried out by means of different sufficient conditions assuring the local semilocal or global convergence This Special issue has allowed us to present the latest research results in the area of iterative processes for solving nonlinear equations as well as systems and matrix equations In addition to the theoretical papers several manuscripts on signal processing nonlinear integral equations or partial differential equations reveal the connection between iterative methods and other branches of science and engineering

Optimization Techniques And Applications: International Conference (In 2 Volumes) F S Chou, T Y Leong, Nee Lam Loh, Kang Hoh Phua, K C Tan, Chien Ming Wang, W Y Yeong, 1992-05-25 With the advent of powerful computers and novel mathematical programming techniques the multidisciplinary field of optimization has advanced to the stage that quite complicated systems can be addressed The conference was organized to provide a platform for the exchanging of new ideas and information and for identifying areas for future research The contributions covered both theoretical techniques and a rich variety of case studies to which optimization can be usefully applied

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