

LINEAR OPERATORS and ILL-POSED PROBLEMS

**M. M. Lavrent'ev
and
L. Ya. Savel'ev**

Linear Operators And Ill Posed Problems

Irina V. Melnikova



Linear Operators And Ill Posed Problems:

Linear Operators and Ill-Posed Problems M.M. Lavrent'ev, L.Ya. Savel'ev, 1995-08-31 In this easily accessible textbook the authors integrate the ill posed problem theory and its underlying mathematical apparatus This comprehensive work includes descriptions of recent results and a presentation of actual applications of the ill posed problem theory The first part of the book describes the differentiation of normed space mappings the integration of the functions of abstract variables and the theory of linear operators The second section deals with the mathematical physics connected to integral equations of the first type and with the bases of operator equation theory

Theory of Linear Ill-Posed Problems and its Applications

Valentin K. Ivanov, Vladimir V. Vasin, Vitalii P. Tanana, 2013-02-18 This monograph is a revised and extended version of the Russian edition from 1978 It includes the general theory of linear ill posed problems concerning e g the structure of sets of uniform regularization the theory of error estimation and the optimality method As a distinguishing feature the book considers ill posed problems not only in Hilbert but also in Banach spaces It is natural that since the appearance of the first edition considerable progress has been made in the theory of inverse and ill posed problems as well as in its applications To reflect these accomplishments the authors included additional material e g comments to each chapter and a list of monographs with annotations

Optimal Methods for Ill-Posed Problems Vitalii P. Tanana, Anna I. Sidikova, 2018-03-19

The book covers fundamentals of the theory of optimal methods for solving ill posed problems as well as ways to obtain accurate and accurate by order error estimates for these methods The methods described in the current book are used to solve a number of inverse problems in mathematical physics Contents Modulus of continuity of the inverse operator and methods for solving ill posed problems Lavrent'ev methods for constructing approximate solutions of linear operator equations of the first kind Tikhonov regularization method Projection regularization method Inverse heat exchange problems

Operator Theory and Its Applications Alexander G. Ramm, P. N. Shivakumar, Abraham Vilgelmovich Strauss, This volume contains a selection of papers presented at an international conference on operator theory and its applications held in Winnipeg The papers chosen for this volume are intended to illustrate that operator theory is the language of modern analysis and its applications Together with the papers on the abstract operator theory are many papers on the theory of differential operators boundary value problems inverse scattering and other inverse problems and on applications to biology chemistry wave propagation and many other areas The volume is dedicated to the late A V Strauss whose principal areas of research were spectral theory of linear operators in Hilbert spaces extension theory for symmetric linear operators theory of the characteristic functions and functional models of linear operators and boundary value problems with boundary conditions depending on spectral parameter The bibliography of publications by A V Strauss combined with the papers from the conference provide both historical perspective and contemporary research on the field of operator theory and its applications

Regularization Algorithms for Ill-Posed Problems Anatoly B. Bakushinsky, Mikhail M. Kokurin, Mikhail Yu.

Kokurin,2018-02-05 This specialized and authoritative book contains an overview of modern approaches to constructing approximations to solutions of ill posed operator equations both linear and nonlinear These approximation schemes form a basis for implementable numerical algorithms for the stable solution of operator equations arising in contemporary mathematical modeling and in particular when solving inverse problems of mathematical physics The book presents in detail stable solution methods for ill posed problems using the methodology of iterative regularization of classical iterative schemes and the techniques of finite dimensional and finite difference approximations of the problems under study Special attention is paid to ill posed Cauchy problems for linear operator differential equations and to ill posed variational inequalities and optimization problems The readers are expected to have basic knowledge in functional analysis and differential equations The book will be of interest to applied mathematicians and specialists in mathematical modeling and inverse problems and also to advanced students in these fields Contents Introduction Regularization Methods For Linear Equations Finite Difference Methods Iterative Regularization Methods Finite Dimensional Iterative Processes Variational Inequalities and Optimization Problems **Inverse and Ill-Posed Problems** Heinz W. Engl,C. W. Groetsch,2014-05-10 Inverse and Ill Posed Problems is a collection of papers presented at a seminar of the same title held in Austria in June 1986 The papers discuss inverse problems in various disciplines mathematical solutions of integral equations of the first kind general considerations for ill posed problems and the various regularization methods for integral and operator equations of the first kind Other papers deal with applications in tomography inverse scattering detection of radiation sources optics partial differential equations and parameter estimation problems One paper discusses three topics on ill posed problems namely the imposition of specified types of discontinuities on solutions of ill posed problems the use of generalized cross validation as a data based termination rule for iterative methods and also a parameter estimation problem in reservoir modeling Another paper investigates a statistical method to determine the truncation level in Eigen function expansions and for Fredholm equations of the first kind where the data contains some errors Another paper examines the use of singular function expansions in the inversion of severely ill posed problems arising in confocal scanning microscopy particle sizing and velocimetry The collection can benefit many mathematicians students and professor of calculus statistics and advanced mathematics

Inverse and Ill-posed Problems Sergey I. Kabanikhin,2011-12-23 The theory of ill posed problems originated in an unusual way As a rule a new concept is a subject in which its creator takes a keen interest The concept of ill posed problems was introduced by Hadamard with the comment that these problems are physically meaningless and not worthy of the attention of serious researchers Despite Hadamard s pessimistic forecasts however his unloved child has turned into a powerful theory whose results are used in many fields of pure and applied mathematics What is the secret of its success The answer is clear Ill posed problems occur everywhere and it is unreasonable to ignore them Unlike ill posed problems inverse problems have no strict mathematical definition In general they can be described as the task of recovering a part of the data

of a corresponding direct well posed problem from information about its solution Inverse problems were first encountered in practice and are mostly ill posed The urgent need for their solution especially in geological exploration and medical diagnostics has given powerful impetus to the development of the theory of ill posed problems Nowadays the terms inverse problem and ill posed problem are inextricably linked to each other Inverse and ill posed problems are currently attracting great interest A vast literature is devoted to these problems making it necessary to systematize the accumulated material This book is the first small step in that direction We propose a classification of inverse problems according to the type of equation unknowns and additional information We consider specific problems from a single position and indicate relationships between them The problems relate to different areas of mathematics such as linear algebra theory of integral equations integral geometry spectral theory and mathematical physics We give examples of applied problems that can be studied using the techniques we describe This book was conceived as a textbook on the foundations of the theory of inverse and ill posed problems for university students The author's intention was to explain this complex material in the most accessible way possible The monograph is aimed primarily at those who are just beginning to get to grips with inverse and ill posed problems but we hope that it will be useful to anyone who is interested in the subject

Ill-Posed Problems With a Priori Information V. V. Vasin, A. L. Ageev, 1995 The Inverse and Ill Posed Problems Series is a series of monographs publishing postgraduate level information on inverse and ill posed problems for an international readership of professional scientists and researchers The series aims to publish works which involve both theory and applications in e g physics medicine geophysics acoustics electrodynamics tomography and ecology

Operator Theory and Ill-Posed Problems Mikhail M. Lavrent'ev, Lev Ja. Savel'ev, 2011-12-22 This book consists of three major parts The first two parts deal with general mathematical concepts and certain areas of operator theory The third part is devoted to ill posed problems It can be read independently of the first two parts and presents a good example of applying the methods of calculus and functional analysis The first part Basic Concepts briefly introduces the language of set theory and concepts of abstract linear and multilinear algebra Also introduced are the language of topology and fundamental concepts of calculus the limit the differential and the integral A special section is devoted to analysis on manifolds The second part Operators describes the most important function spaces and operator classes for both linear and nonlinear operators Different kinds of generalized functions and their transformations are considered Elements of the theory of linear operators are presented Spectral theory is given a special focus The third part Ill Posed Problems is devoted to problems of mathematical physics integral and operator equations evolution equations and problems of integral geometry It also deals with problems of analytic continuation Detailed coverage of the subjects and numerous examples and exercises make it possible to use the book as a textbook on some areas of calculus and functional analysis It can also be used as a reference textbook because of the extensive scope and detailed references with comments

Blind Image Deconvolution Subhasis Chaudhuri, Rajbabu Velmurugan, Renu

Rameshan,2014-09-22 Blind deconvolution is a classical image processing problem which has been investigated by a large number of researchers over the last four decades The purpose of this monograph is not to propose yet another method for blind image restoration Rather the basic issue of deconvolvability has been explored from a theoretical view point Some authors claim very good results while quite a few claim that blind restoration does not work The authors clearly detail when such methods are expected to work and when they will not In order to avoid the assumptions needed for convergence analysis in the Fourier domain the authors use a general method of convergence analysis used for alternate minimization based on three point and four point properties of the points in the image space The authors prove that all points in the image space satisfy the three point property and also derive the conditions under which four point property is satisfied This provides the conditions under which alternate minimization for blind deconvolution converges with a quadratic prior Since the convergence properties depend on the chosen priors one should design priors that avoid trivial solutions Hence a sparsity based solution is also provided for blind deconvolution by using image priors having a cost that increases with the amount of blur which is another way to prevent trivial solutions in joint estimation This book will be a highly useful resource to the researchers and academicians in the specific area of blind deconvolution Optimization, Variational Analysis and Applications

Vivek Laha,Pierre Maréchal,S. K. Mishra,2021-07-27 This book includes selected papers presented at the Indo French Seminar on Optimization Variational Analysis and Applications IFSOVAA 2020 held at the Department of Mathematics Institute of Science Banaras Hindu University Varanasi India from 2 4 February 2020 The book discusses current optimization problems and their solutions by using the powerful tool of variational analysis Topics covered in this volume include set optimization multiobjective optimization mathematical programs with complementary equilibrium vanishing and switching constraints copositive optimization interval valued optimization sequential quadratic programming bound constrained optimization variational inequalities and more Several applications in different branches of applied mathematics engineering economics finance and medical sciences have been included Each chapter not only provides a detailed survey of the topic but also builds systematic theories and suitable algorithms to deduce the most recent findings in literature This volume appeals to graduate students as well as researchers and practitioners in pure and applied mathematics and related fields that make use of variational analysis in solving optimization problems **Inverse Problems in the**

Mathematical Sciences Charles W. Groetsch,2013-12-14 Classical applied mathematics is dominated by the Laplacian paradigm of known causes evolving continuously into uniquely determined effects The classical direct problem is then to find the unique effect of a given cause by using the appropriate law of evolution It is therefore no surprise that traditional teaching in mathematics and the natural sciences emphasizes the point of view that problems have a solution this solution is unique and the solution is insensitive to small changes in the problem Such problems are called well posed and they typically arise from the so called direct problems of natural science The demands of science and technology have recently brought to

the fore many problems that are inverse to the classical direct problems that is problems which may be interpreted as finding the cause of a given effect or finding the law of evolution given the cause and effect Included among such problems are many questions of remote sensing or indirect measurement such as the determination of internal characteristics of an inaccessible region from measurements on its boundary the determination of system parameters from input output measurements and the reconstruction of past events from measurements of the present state Inverse problems of this type are often ill posed in the sense that distinct causes can account for the same effect and small changes in a perceived effect can correspond to very large changes in a given cause Very frequently such inverse problems are modeled by integral equations of the first kind

Handbook of Mathematical Geodesy Willi Freeden,M. Zuhair Nashed,2018-06-11 Written by leading experts this book provides a clear and comprehensive survey of the status quo of the interrelating process and cross fertilization of structures and methods in mathematical geodesy Starting with a foundation of functional analysis potential theory constructive approximation special function theory and inverse problems readers are subsequently introduced to today s least squares approximation spherical harmonics reflected spline and wavelet concepts boundary value problems Runge Walsh framework geodetic observables geoidal modeling ill posed problems and regularizations inverse gravimetry and satellite gravity gradiometry All chapters are self contained and can be studied individually making the book an ideal resource for both graduate students and active researchers who want to acquaint themselves with the mathematical aspects of modern geodesy

New Trends in Parameter Identification for Mathematical Models Bernd Hofmann,Antonio Leitão,Jorge P. Zubelli,2018-02-13 The Proceedings volume contains 16 contributions to the IMPA conference New Trends in Parameter Identification for Mathematical Models Rio de Janeiro Oct 30 Nov 3 2017 integrating the Chemnitz Symposium on Inverse Problems on Tour This conference is part of the Thematic Program on Parameter Identification in Mathematical Models organized at IMPA in October and November 2017 One goal is to foster the scientific collaboration between mathematicians and engineers from the Brazilian European and Asian communities Main topics are iterative and variational regularization methods in Hilbert and Banach spaces for the stable approximate solution of ill posed inverse problems novel methods for parameter identification in partial differential equations problems of tomography solution of coupled conduction radiation problems at high temperatures and the statistical solution of inverse problems with applications in physics

Large Scale Inverse Problems Mike Cullen,Melina A Freitag,Stefan Kindermann,Robert Scheichl,2013-08-29 This book is thesecond volume of a three volume series recording the Radon Special Semester 2011 on Multiscale Simulation Analysis in Energy and the Environment that took place in Linz Austria October 3 7 2011 This volume addresses the common ground in the mathematical and computational procedures required for large scale inverse problems and data assimilation in forefront applications The solution of inverse problems is fundamental to a wide variety of applications such as weather forecasting medical tomography and oil exploration Regularisation techniques are needed to ensure solutions of sufficient quality to be

useful and soundly theoretically based This book addresses the common techniques required for all the applications and is thus truly interdisciplinary This collection of survey articles focusses on the large inverse problems commonly arising in simulation and forecasting in the earth sciences For example operational weather forecasting models have between 10⁷ and 10⁸ degrees of freedom Even so these degrees of freedom represent grossly space time averaged properties of the atmosphere Accurate forecasts require accurate initial conditions With recent developments in satellite data there are between 10⁶ and 10⁷ observations each day However while these also represent space time averaged properties the averaging implicit in the measurements is quite different from that used in the models In atmosphere and ocean applications there is a physically based model available which can be used to regularise the problem We assume that there is a set of observations with known error characteristics available over a period of time The basic deterministic technique is to fit a model trajectory to the observations over a period of time to within the observation error Since the model is not perfect the model trajectory has to be corrected which defines the data assimilation problem The stochastic view can be expressed by using an ensemble of model trajectories and calculating corrections to both the mean value and the spread which allow the observations to be fitted by each ensemble member In other areas of earth science only the structure of the model formulation itself is known and the aim is to use the past observation history to determine the unknown model parameters The book records the achievements of Workshop2 Large Scale Inverse Problems and Applications in the Earth Sciences It involves experts in the theory of inverse problems together with experts working on both theoretical and practical aspects of the techniques by which large inverse problems arise in the earth sciences *Theory and Applications of Nonlinear Operators of Accretive and Monotone Type* Athanass Kartsatos, 1996-03-14 This work is based upon a Special Session on the Theory and Applications of Nonlinear Operators of Accretive and Monotone Type held during the recent meeting of the American Mathematical Society in San Francisco It examines current developments in non linear analysis emphasizing accretive and monotone operator theory The book presents a major survey research article on partial functional differential equations with delay and an important survey research article on approximation solvability Operator Theory, Functional Analysis and Applications M. Amélia Bastos, Luís Castro, Alexei Yu. Karlovich, 2021-03-31 This book presents 30 articles on the topic areas discussed at the 30th International Workshop on Operator Theory and its Applications held in Lisbon in July 2019 The contributions include both expository essays and original research papers reflecting recent advances in the traditional IWOTA areas and emerging adjacent fields as well as the applications of Operator Theory and Functional Analysis The topics range from C algebras and Banach algebras Sturm Liouville theory integrable systems dilation theory frame theory Toeplitz Hankel and singular integral operators to questions from lattice group and matrix theories complex analysis harmonic analysis and function spaces Given its scope the book is chiefly intended for researchers and graduate students in the areas of Operator Theory Functional Analysis their applications and adjacent fields **Stochastic Cauchy Problems in Infinite**

Dimensions Irina V. Melnikova, 2018-09-03 Stochastic Cauchy Problems in Infinite Dimensions Generalized and Regularized Solutions presents stochastic differential equations for random processes with values in Hilbert spaces Accessible to non specialists the book explores how modern semi group and distribution methods relate to the methods of infinite dimensional stochastic analysis It also shows how the idea of regularization in a broad sense pervades all these methods and is useful for numerical realization and applications of the theory The book presents generalized solutions to the Cauchy problem in its initial form with white noise processes in spaces of distributions It also covers the classical approach to stochastic problems involving the solution of corresponding integral equations The first part of the text gives a self contained introduction to modern semi group and abstract distribution methods for solving the homogeneous deterministic Cauchy problem In the second part the author solves stochastic problems using semi group and distribution methods as well as the methods of infinite dimensional stochastic analysis Inverse Acoustic and Electromagnetic Scattering Theory David Colton, Rainer Kress, 2012-10-26 The inverse scattering problem is central to many areas of science and technology such as radar and sonar medical imaging geophysical exploration and nondestructive testing This book is devoted to the mathematical and numerical analysis of the inverse scattering problem for acoustic and electromagnetic waves In this third edition new sections have been added on the linear sampling and factorization methods for solving the inverse scattering problem as well as expanded treatments of iteration methods and uniqueness theorems for the inverse obstacle problem These additions have in turn required an expanded presentation of both transmission eigenvalues and boundary integral equations in Sobolev spaces As in the previous editions emphasis has been given to simplicity over generality thus providing the reader with an accessible introduction to the field of inverse scattering theory Review of earlier editions Colton and Kress have written a scholarly state of the art account of their view of direct and inverse scattering The book is a pleasure to read as a graduate text or to dip into at leisure It suggests a number of open problems and will be a source of inspiration for many years to come SIAM Review September 1994 This book should be on the desk of any researcher any student any teacher interested in scattering theory Mathematical Intelligencer June 1994 Inverse Problems and Carleman Estimates Michael V. Klibanov, Jingzhi Li, 2021-09-07 This book summarizes the main analytical and numerical results of Carleman estimates In the analytical part Carleman estimates for three main types of Partial Differential Equations PDEs are derived In the numerical part first numerical methods are proposed to solve ill posed Cauchy problems for both linear and quasilinear PDEs Next various versions of the convexification method are developed for a number of Coefficient Inverse Problems

The Enigmatic Realm of **Linear Operators And Ill Posed Problems**: Unleashing the Language is Inner Magic

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