Computational Methods For Inverse Problems Frontiers In Applied Mathematics S

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ALINA JOURNEY

Tikhonov Theory and Algorithms SIAM
These ten detailed and authoritative survey articles on numerical methods for direct and inverse wave propagation problems are written by leading experts. Researchers and practitioners in computational wave propagation, from postgraduate level onwards, will find the breadth and depth of coverage of recent developments a valuable resource. The articles describe a wide range of topics on the application and analysis of methods for time and frequency domain PDE and boundary integral formulations of wave propagation problems. Electromagnetic, seismic and acoustic equations are considered. Recent developments in methods and analysis ranging from finite differences to hp-adaptive finite elements, including high-accuracy and fast methods are described with extensive references.
Survey of Computational Methods for Inverse Problems John Wiley & Sons
While the prediction of observations is a forward problem, the use of actual observations to infer the properties of a model is an inverse problem. Inverse problems are difficult because they may not have a unique solution. The description of uncertainties plays a

central role in the theory, which is based on probability theory. This book proposes a general approach that is valid for linear as well as for nonlinear problems. The philosophy is essentially probabilistic and allows the reader to understand the basic difficulties appearing in the resolution of inverse problems. The book attempts to explain how a method of acquisition of information can be applied to actual real-world problems, and many of the arguments are heuristic.

Computational Methods for Applied Inverse Problems Walter de Gruyter

Annotation Rodgers (U. of Oxford) provides graduate students and other researchers a background to the inverse problem and its solution, with applications relating to atmospheric measurements. He introduces the stages in the reverse order than the usual approach in order to develop the learner's intuition about the nature of the inverse problem. Annotation copyrighted by Book News, Inc., Portland, OR.

Computational Methods for Inverse Problems SIAM

The retrieval problems arising in atmospheric remote sensing belong to the class of the - called discrete ill-posed problems. These problems are unstable under data perturbations, and can be solved by numerical regularization methods, in which the solution is stabilized by taking additional information into account. The goal of this

research monograph is to present and analyze numerical algorithms for atmospheric retrieval. The book is aimed at physicists and engineers with some ba- ground in numerical linear algebra and matrix computations. Although there are many practical details in this book, for a robust and ef?cient implementation of all numerical algorithms, the reader should consult the literature cited. The data model adopted in our analysis is semi-stochastic. From a practical point of view, there are no signi?cant differences between a semi-stochastic and a determin- tic framework; the differences are relevant from a theoretical point of view, e.g., in the convergence and convergence rates analysis. After an introductory chapter providing the state of the art in passive atmospheric remote sensing, Chapter 2 introduces the concept of ill-posedness for linear discrete eq- tions. To illustrate the dif?culties associated with the solution of discrete ill-posed pr- lems, we consider the temperature retrieval by nadir sounding and analyze the solvability of the discrete equation by using the singular value decomposition of the forward model matrix.

Parameter Estimation and Inverse Problems

Springer Science & Business Media

This book presents important recent developments in mathematical and computational methods used in impedance

imaging and the theory of composite materials. By augmenting the theory with interesting practical examples and numerical illustrations, the exposition brings simplicity to the advanced material. An introductory chapter covers the necessary basics. An extensive bibliography and open problems at the end of each chapter enhance the text.

Inverse Problem Theory and Methods for Model Parameter Estimation

Wiley-IEEE Press

Inverse problems occur in a wide range of scientific applications, such as in the fields of signal processing, medical imaging, or geophysics. This work aims to present to the field practitioners, in an accessible and concise way, several established and newer cutting-edge computational methods used in the field of inverse problems-and when and how these techniques should be employed.

Inverse Methods for Atmospheric Sounding

Springer Science & Business Media

Inverse problems need to be solved in order to properly interpret indirect measurements. Often, inverse problems are ill-posed and sensitive to data errors. Therefore one has to incorporate some sort of regularization to reconstruct significant information from the given data. This book presents the main achievements that have emerged in regularization theory over the past 50 years, focusing on linear ill-posed problems and the development of methods that can be

applied to them. Some of this material has previously appeared only in journal articles. A Taste of Inverse Problems: Basic Theory and Examples rigorously discusses state-of-the-art inverse problems theory, focusing on numerically relevant aspects and omitting subordinate generalizations;presents diverse real-world applications, important test cases, and possible pitfalls; and treats these applications with the same rigor and depth as the theory.

Computational Methods in Geophysical Electromagnetics Springer Nature

"Fixed-Point Algorithms for Inverse Problems in Science and Engineering" presents some of the most recent work from top-notch researchers studying projection and other first-order fixed-point algorithms in several areas of mathematics and the applied sciences. The material presented provides a survey of the state-of-the-art theory and practice in fixed-point algorithms, identifying emerging problems driven by applications, and discussing new approaches for solving these problems. This book incorporates diverse perspectives from broad-ranging areas of research including, variational analysis, numerical linear algebra, biotechnology, materials science, computational solid-state physics, and chemistry. Topics presented include: Theory of Fixed-point algorithms: convex analysis, convex optimization,

subdifferential calculus, nonsmooth analysis, proximal point methods, projection methods, resolvent and related fixed-point theoretic methods, and monotone operator theory. Numerical analysis of fixed-point algorithms: choice of step lengths, of weights, of blocks for block-iterative and parallel methods, and of relaxation parameters; regularization of ill-posed problems; numerical comparison of various methods. Areas of Applications: engineering (image and signal reconstruction and decompression problems), computer tomography and radiation treatment planning (convex feasibility problems), astronomy (adaptive optics), crystallography (molecular structure reconstruction), computational chemistry (molecular structure simulation) and other areas. Because of the variety of applications presented, this book can easily serve as a basis for new and innovated research and collaboration.

Direct and Inverse Problems John Wiley & Sons

The Handbook of Mathematical Methods in Imaging provides a comprehensive treatment of the mathematical techniques used in imaging science. The material is grouped into two central themes, namely, Inverse Problems (Algorithmic Reconstruction) and Signal and Image Processing. Each section within the themes covers applications (modeling),

mathematics, numerical methods (using a case example) and open questions. Written by experts in the area, the presentation is mathematically rigorous. The entries are cross-referenced for easy navigation through connected topics. Available in both print and electronic forms, the handbook is enhanced by more than 150 illustrations and an extended bibliography. It will benefit students, scientists and researchers in applied mathematics.

Engineers and computer scientists working in imaging will also find this handbook useful.

5th International Workshop on New Computational Methods for Inverse Problems (NCMIP 2015) Springer Science & Business Media

This book gives an introduction to the practical treatment of inverse problems by means of numerical methods, with a focus on basic mathematical and computational aspects. To solve inverse problems, we demonstrate that insight about them goes hand in hand with algorithms.

Numerical Methods for Inverse Problems Springer Science & Business Media

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 placein 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. Thiscollection of surveyarticlesfocusses onthe 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". Itinvolves 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.

Basic Theory and Examples SIAM

This monograph provides a framework for students and practitioners who are working on the solution of electromagnetic imaging in geophysics. Bridging the gap between theory and practical applied material (for example, inverse and forward problems), it provides a simple explanation of finite volume discretization, basic concepts in solving

inverse problems through optimization, a summary of applied electromagnetics methods, and MATLAB?÷code for efficient computation.

An Introduction to Bayesian Scientific Computing SIAM

In verse problems arise in a number of important practical applications, ranging from biomedical imaging to seismic prospecting. This book provides the reader with a basic understanding of both the underlying mathematics and the computational methods used to solve inverse problems. It also addresses specialized topics like image reconstruction, parameter identification, total variation methods, nonnegativity constraints, and regularization parameter selection methods. Because inverse problems typically involve the estimation of certain quantities based on indirect measurements, the estimation process is often ill-posed. Regularization methods, which have been developed to deal with this ill-posedness, are carefully explained in the early chapters of Computational Methods for Inverse Problems. The book also integrates mathematical and statistical theory with applications and practical computational methods, including topics like maximum likelihood estimation and Bayesian estimation. Several web-based resources are available to make this monograph interactive, including a collection of MATLAB m-files used to

generate many of the examples and figures.
Computational Methods for Inverse Problems SIAM
Provides a basic understanding of both the underlying mathematics and the computational methods used to solve inverse problems.
Polarization and Moment Tensors
Springer Science & Business Media
A comprehensive description of the current theoretical and numerical aspects of inverse problems in partial differential equations. Applications include recovery of inclusions from anomalies of their gravity fields, reconstruction of the interior of the human body from exterior electrical, ultrasonic, and magnetic measurement. By presenting the data in a readable and informative manner, the book introduces both scientific and engineering researchers as well as graduate students to the significant work done in this area in recent years, relating it to broader themes in mathematical analysis.
Numerical Methods for Solving Inverse Problems of Mathematical Physics
SIAM
This book focuses on computational methods for large-scale statistical inverse problems and provides an introduction to statistical Bayesian and frequentist methodologies. Recent research advances for approximation methods are discussed, along with Kalman filtering methods and optimization-based approaches to solving

inverse problems. The aim is to cross-fertilize the perspectives of researchers in the areas of data assimilation, statistics, large-scale optimization, applied and computational mathematics, high performance computing, and cutting-edge applications. The solution to large-scale inverse problems critically depends on methods to reduce computational cost. Recent research approaches tackle this challenge in a variety of different ways. Many of the computational frameworks highlighted in this book build upon state-of-the-art methods for simulation of the forward problem, such as, fast Partial Differential Equation (PDE) solvers, reduced-order models and emulators of the forward problem, stochastic spectral approximations, and ensemble-based approximations, as well as exploiting the machinery for large-scale deterministic optimization through adjoint and other sensitivity analysis methods. Key Features: Brings together the perspectives of researchers in areas of inverse problems and data assimilation. Assesses the current state-of-the-art and identify needs and opportunities for future research. Focuses on the computational methods used to analyze and simulate inverse problems. Written by leading experts of inverse problems and uncertainty quantification. Graduate students and researchers working in statistics, mathematics and

engineering will benefit from this book.
Computational Methods for Inverse Problems
Springer Science & Business Media
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Springer Nature
This monograph deals with some inverse problems of mathematical physics. It introduces new methods for studying inverse problems and gives obtained results, which are related to the conditional well posedness of the problems. The main focus lies on time-domain inverse problems for hyperbolic equations and the kinetic transport equation.
Numerical Regularization for Atmospheric Inverse Problems Society for Industrial & Applied
This book provides researchers and engineers in the imaging field with the skills they need to effectively deal with nonlinear inverse problems associated with different imaging modalities, including impedance imaging, optical tomography, elastography, and electrical source imaging. Focusing on numerically implementable methods, the book bridges the gap

between theory and applications, helping readers tackle problems in applied mathematics and engineering. Complete, self-contained coverage includes basic concepts, models, computational methods, numerical simulations, examples, and case studies. Provides a step-by-step progressive treatment of topics for ease of understanding. Discusses the underlying physical phenomena as well as implementation details of image reconstruction algorithms as prerequisites for finding solutions to non linear inverse problems with practical significance and value. Includes end of chapter problems, case studies and examples with solutions throughout the book. Companion website will provide further examples and solutions, experimental data sets, open problems, teaching material such as PowerPoint slides and software including MATLAB m files. Essential reading for Graduate students and researchers in imaging science working across the areas of applied mathematics, biomedical engineering, and electrical engineering and specifically those involved in nonlinear imaging techniques, impedance imaging, optical tomography, elastography, and electrical source imaging

Insight and Algorithms

Springer Science & Business Media

This book has been written for undergraduate and graduate students in various disciplines of mathematics. The authors, internationally

recognized experts in their field, have developed a superior teaching and learning tool that makes it easy to grasp new concepts and apply them in practice. The book's highly accessible approach makes it particularly ideal if you want to become acquainted with the Bayesian approach to computational science, but do not need to be fully immersed in detailed statistical analysis.