

Introduction To Inverse Problems In Imaging

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Introduction to Inverse Problems in Imaging Mario Bertero 1998 This is a graduate textbook on the principles of linear inverse problems, methods of their approximate solution, and practical application in imaging. The level of mathematical treatment is kept as low as possible to make the book suitable for a wide range of readers from different backgrounds in science and engineering. Mathematical prerequisites are first courses in analysis, geometry, linear algebra, probability theory, and Fourier analysis. The authors concentrate on presenting easily implementable and fast solution algorithms. With examples and exercised throughout, the book will provide the reader with the appropriate background for a clear understanding of the essence of inverse problems (ill-posedness and its cure) and, consequently, for an intelligent assessment of the rapidly growing literature on these problems.

Geophysical Inverse Theory and Regularization Problems Michael S. Zhdanov 2002-04-24 This book presents state-of-the-art geophysical inverse theory developed in modern mathematical terminology. The book brings together fundamental results developed by the Russian mathematical school in regularization theory and combines them with the related research in geophysical inversion carried out in the West. It presents a detailed exposition of the methods of regularized solution of inverse problems based on the ideas of Tikhonov regularization, and shows the different forms of their applications in both linear and nonlinear methods of geophysical inversion. This text is the first to treat many kinds of inversion and imaging techniques in a unified mathematical manner. The book is divided in five parts covering the foundations of the inversion theory and its applications to the solution of different geophysical inverse problems, including potential field, electromagnetic, and seismic

methods. The first part is an introduction to inversion theory. The second part contains a description of the basic methods of solution of the linear and nonlinear inverse problems using regularization. The following parts treat the application of regularization methods in gravity and magnetic, electromagnetic, and seismic inverse problems. The key connecting idea of these applied parts of the book is the analogy between the solutions of the forward and inverse problems in different geophysical methods. The book also includes chapters related to the modern technology of geophysical imaging, based on seismic and electromagnetic migration. This volume is unique in its focus on providing a link between the methods used in gravity, electromagnetic, and seismic imaging and inversion, and represents an exhaustive treatise on inversion theory.

Inverse Problems in the Mathematical Sciences Charles W. Groetsch 2013-12-14 Inverse problems are immensely important in modern science and technology. However, the broad mathematical issues raised by inverse problems receive scant attention in the university curriculum. This book aims to remedy this state of affairs by supplying an accessible introduction, at a modest mathematical level, to the alluring field of inverse problems. Many models of inverse problems from science and engineering are dealt with and nearly a hundred exercises, of varying difficulty, involving mathematical analysis, numerical treatment, or modelling of inverse problems, are provided. The main themes of the book are: causation problem modeled as integral equations; model identification problems, posed as coefficient determination problems in differential equations; the functional analytic framework for inverse problems; and a survey of the principal numerical methods for inverse problems. An extensive annotated bibliography furnishes leads on the history of inverse problems and a guide to the frontiers of current research.

Introduction to Inverse Problems in Imaging M. Bertero 2017-07-27 This is a graduate textbook on the principles of linear inverse problems, methods of their approximate solution, and practical application in imaging. The level of mathematical treatment is kept as low as possible to make the book suitable for a wide range of readers from different backgrounds in science and engineering. Mathematical prerequisites are first courses in analysis, geometry, linear algebra, probability theory, and Fourier analysis. The authors concentrate on presenting easily implementable and fast solution algorithms. With examples and exercised throughout, the book will provide the reader with the appropriate background for a clear understanding of the essence of inverse problems (ill-posedness and its cure) and, consequently, for an intelligent assessment of the rapidly growing literature on these problems.

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problems.

Introduction to the Mathematics of Medical Imaging Charles L. Epstein 2008-01-01 At the heart of every medical imaging technology is a sophisticated mathematical model of the measurement process and an algorithm to reconstruct an image from the measured data. This book provides a firm foundation in the mathematical tools used to model the measurements and derive the reconstruction algorithms used in most of these modalities. The text uses X-ray computed tomography (X-ray CT) as a 'pedagogical machine' to illustrate important ideas and its extensive discussion of background material makes the more advanced mathematical topics accessible to people with a less formal mathematical education. This new edition contains a chapter on magnetic resonance imaging (MRI), a revised section on the relationship between the continuum and discrete Fourier transforms, an improved description of the gridding method, and new sections on both Grangreat's formula and noise analysis in MR-imaging. Mathematical concepts are illuminated with over 200 illustrations and numerous exercises.

Inverse Problems and Imaging Luis L. Bonilla 2009-06-19 Nowadays we are facing numerous and important imaging problems: nondestructive testing of materials, monitoring of industrial processes, enhancement of oil production by efficient reservoir characterization, emerging developments in noninvasive imaging techniques for medical purposes - computerized tomography (CT), magnetic resonance imaging (MRI), positron emission tomography (PET), X-ray and ultrasound tomography, etc. In the CIME Summer School on Imaging (Martina Franca, Italy 2002), leading experts in mathematical techniques and applications presented broad and useful introductions for non-experts and practitioners alike to many aspects of this exciting field. The volume contains part of the above lectures completed and updated by additional contributions on other related topics.

Modeling and Inverse Problems in Imaging Analysis Bernard Chalmond 2003-01-14 More mathematicians have been taking part in the development of digital image processing as a science and the contributions are reflected in the increasingly important role modeling has played solving complex problems. This book is mostly concerned with energy-based models. Most of these models come from industrial projects in which the author was involved in robot vision and radiography: tracking 3D lines, radiographic image processing, 3D reconstruction and tomography, matching, deformation learning. Numerous graphical illustrations accompany the text.

Polarization and Moment Tensors Habib Ammari 2007-06-16 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 Problems and Applications Gunther Uhlmann 2013 Inverse problems lie at the heart of contemporary scientific inquiry and technological development. Applications include a variety of medical and other imaging techniques, which are used for early detection of cancer and pulmonary edema, location of oil and mineral deposits in the Earth's interior, creation of astrophysical

images from telescope data, finding cracks and interfaces within materials, shape optimization, model identification in growth processes, and modeling in the life sciences among others. The expository survey essays in this book describe recent developments in inverse problems and imaging, including hybrid or couple-physics methods arising in medical imaging, Calderon's problem and electrical impedance tomography, inverse problems arising in global seismology and oil exploration, inverse spectral problems, and the study of asymptotically hyperbolic spaces. It is suitable for graduate students and researchers interested in inverse problems and their applications.

Introduction to Inverse Problems in Imaging M. Bertero 2021-12-20 Fully updated throughout and with several new chapters, this second edition of Introduction to Inverse Problems in Imaging guides advanced undergraduate and graduate students in physics, computer science, mathematics and engineering through the principles of linear inverse problems, in addition to methods of their approximate solution and their practical applications in imaging. This second edition contains new chapters on edge-preserving and sparsity-enforcing regularization in addition to maximum likelihood methods and Bayesian regularization for Poisson data. The level of mathematical treatment is kept as low as possible to make the book suitable for a wide range of students from different backgrounds, with readers needing just a rudimentary understanding of analysis, geometry, linear algebra, probability theory, and Fourier analysis. The authors concentrate on presenting easily implementable and fast solution algorithms, and this second edition is accompanied by numerical examples throughout. It will provide readers with the appropriate background needed for a clear understanding of the essence of inverse problems (ill-posedness and its cure) and, consequently, for an intelligent assessment of the rapidly growing literature on these problems. Key features: Provides an accessible introduction to the topic while keeping mathematics to a minimum Interdisciplinary topic with growing relevance and wide-ranging applications Accompanied by numerical examples throughout

Parameter Estimation and Inverse Problems Richard C. Aster 2013 Parameter Estimation and Inverse Problems, Second Edition provides geoscience students and professionals with answers to common questions like how one can derive a physical model from a finite set of observations containing errors, and how one may determine the quality of such a model. This book takes on these fundamental and challenging problems, introducing students and professionals to the broad range of approaches that lie in the realm of inverse theory. The authors present both the underlying theory and practical algorithms for solving inverse problems. The authors' treatment is appropriate for geoscience graduate students and advanced undergraduates with a basic working knowledge of calculus, linear algebra, and statistics. Parameter Estimation and Inverse Problems, Second Edition introduces readers to both Classical and Bayesian approaches to linear and nonlinear problems with particular attention paid to computational, mathematical, and statistical issues related to their application to geophysical problems. The textbook includes Appendices covering essential linear algebra, statistics, and notation in the context of the subject. Includes appendices for review of needed concepts in linear, statistics, and vector calculus. Accessible to students and professionals without a highly specialized

mathematical background.

Inverse Methods in Action Pierre C. Sabatier 2012-12-06 This volume contains the Proceedings of a meeting held at Montpellier from November 27th to December 1st 1989 and entitled "Inverse Problems Multicentennial Meeting". It was held in honor of two major centennials: the foundation of Montpellier University in 1289 and the French Revolution of 1789. The meeting was one of a series of annual meetings on interdisciplinary aspects of inverse problems organized in Montpellier since 1972 and known as "RCP 264". The meeting was sponsored by the Centre National de la Recherche Scientifique (contract GR 264) and by the Direction des Recherches et Etudes Techniques (contract 88 CO 283). The Proceedings are presented by chapters on different topics, the choice of topic often being arbitrary. The chapter titles are "Tomographic Inverse Problems", "Distributed Parameters Inverse Problems", "Spectral Inverse Problems (Exact Methods)", "Theoretical Imaging", "Wave Propagation and Scattering Problems (Imaging and Numerical Methods)", "Miscellaneous Problems", "Inverse Methods and Applications to Nonlinear Problems". In each chapter but the first, the papers have been sorted alphabetically according to author*. In the first chapter, a set of theoretical papers is presented first, then more applied ones. There are so many well-known and excellent lectures that I will not try to refer to them all here (the reader will be easily convinced by reading the Table of Contents). My comments at the conference are summarized by the short scientific introduction at the beginning of the volume.

Computational Methods for Applied Inverse Problems Yanfei Wang 2012-10-30 This monograph reports recent advances of inversion theory and recent developments with practical applications in frontiers of sciences, especially inverse design and novel computational methods for inverse problems. Readers who do research in applied mathematics, engineering, geophysics, biomedicine, image processing, remote sensing, and environmental science will benefit from the contents since the book incorporates a background of using statistical and non-statistical methods, e.g., regularization and optimization techniques for solving practical inverse problems.

Introduction to Imaging from Scattered Fields Michael A Fiddy 2014-11-10 Obtain the Best Estimate of a Strongly Scattering Object from Limited Scattered Field Data Introduction to Imaging from Scattered Fields presents an overview of the challenging problem of determining information about an object from measurements of the field scattered from that object. It covers widely used approaches to recover information about the objects and examines the assumptions made a priori about the object and the consequences of recovering object information from limited numbers of noisy measurements of the scattered fields. The book explores the strengths and weaknesses of using inverse methods for weak scattering. These methods, including Fourier-based signal and image processing techniques, allow more straightforward inverse algorithms to be exploited based on a simple mapping of scattered field data. The authors also discuss their recent approach based on a nonlinear filtering step in the inverse algorithm. They illustrate how to use this algorithm through numerous two-dimensional electromagnetic scattering examples. MATLAB® code is provided to help readers quickly apply the approach to a wide variety of inverse scattering problems. In later chapters of the book, the authors focus on important and often forgotten overarching constraints associated with exploiting

inverse scattering algorithms. They explain how the number of degrees of freedom associated with any given scattering experiment can be found and how this allows one to specify a minimum number of data that should be measured. They also describe how the prior discrete Fourier transform (PDFT) algorithm helps in estimating the properties of an object from scattered field measurements. The PDFT restores stability and improves estimates of the object even with severely limited data (provided it is sufficient to meet a criterion based on the number of degrees of freedom). Suitable for graduate students and researchers working on medical, geophysical, defense, and industrial inspection inverse problems, this self-contained book provides the necessary details for readers to design improved experiments and process measured data more effectively. It shows how to obtain the best estimate of a strongly scattering object from limited scattered field data.

Inverse and Ill-Posed Problems Heinz W. Engl 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.

Bayesian Approach to Inverse Problems Jérôme Idier 2013-03-01 Many scientific, medical or engineering problems raise the issue of recovering some physical quantities from indirect measurements; for instance, detecting or quantifying flaws or cracks within a material from acoustic or electromagnetic measurements at its surface is an essential problem of non-destructive evaluation. The concept of inverse problems precisely originates from the idea of inverting the laws of physics to recover a quantity of interest from measurable data. Unfortunately, most inverse problems are ill-posed, which means that precise and stable solutions are not easy to devise. Regularization is the key concept to solve inverse problems. The goal of this book is to deal with inverse problems and regularized solutions using the Bayesian statistical tools, with a particular view to signal and image estimation. The first three chapters bring the theoretical notions that make it possible to cast inverse problems within a mathematical framework. The next three chapters address the fundamental inverse problem of deconvolution in a comprehensive manner. Chapters 7 and 8 deal with advanced statistical questions linked to image estimation. In the last five chapters, the main tools introduced in the previous chapters are put into a practical context in important applicative areas, such as astronomy or

medical imaging.

Linear and Nonlinear Inverse Problems with Practical Applications Jennifer L. Mueller 2012-11-30 Inverse problems arise in practical applications whenever there is a need to interpret indirect measurements. This book explains how to identify ill-posed inverse problems arising in practice and gives a hands-on guide to designing computational solution methods for them, with related codes on an accompanying website. The guiding linear inversion examples are the problem of image deblurring, x-ray tomography, and backward parabolic problems, including heat transfer. A thorough treatment of electrical impedance tomography is used as the guiding nonlinear inversion example which combines the analytic-geometric research tradition and the regularization-based school of thought in a fruitful manner. This book is complete with exercises and project topics, making it ideal as a classroom textbook or self-study guide for graduate and advanced undergraduate students in mathematics, engineering or physics who wish to learn about computational inversion. It also acts as a useful guide for researchers who develop inversion techniques in high-tech industry.

Regularization and Bayesian Methods for Inverse Problems in Signal and Image Processing Jean-Francois Giovannelli 2015-02-02 The focus of this book is on "ill-posed inverse problems". These problems cannot be solved only on the basis of observed data. The building of solutions involves the recognition of other pieces of a priori information. These solutions are then specific to the pieces of information taken into account. Clarifying and taking these pieces of information into account is necessary for grasping the domain of validity and the field of application for the solutions built. For too long, the interest in these problems has remained very limited in the signal-image community. However, the community has since recognized that these matters are more interesting and they have become the subject of much greater enthusiasm. From the application field's point of view, a significant part of the book is devoted to conventional subjects in the field of inversion: biological and medical imaging, astronomy, non-destructive evaluation, processing of video sequences, target tracking, sensor networks and digital communications. The variety of chapters is also clear, when we examine the acquisition modalities at stake: conventional modalities, such as tomography and NMR, visible or infrared optical imaging, or more recent modalities such as atomic force imaging and polarized light imaging.

Introduction to Inverse Problems in Imaging M. Bertero 2020-08-30 This is a graduate textbook on the principles of linear inverse problems, methods of their approximate solution, and practical application in imaging. The level of mathematical treatment is kept as low as possible to make the book suitable for a wide range of readers from different backgrounds in science and engineering. Mathematical prerequisites are first courses in analysis, geometry, linear algebra, probability theory, and Fourier analysis. The authors concentrate on presenting easily implementable and fast solution algorithms. With examples and exercises throughout, the book will provide the reader with the appropriate background for a clear understanding of the essence of inverse problems (ill-posedness and its cure) and, consequently, for an intelligent assessment of the rapidly growing literature on these

problems.

Regularization of Inverse Problems Heinz Werner Engl 2000-03-31 This book is devoted to the mathematical theory of regularization methods and gives an account of the currently available results about regularization methods for linear and nonlinear ill-posed problems. Both continuous and iterative regularization methods are considered in detail with special emphasis on the development of parameter choice and stopping rules which lead to optimal convergence rates.

Large-Scale Inverse Problems and Quantification of Uncertainty Lorenz Biegler 2010-11-15 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.

Fourier Optics and Computational Imaging Kedar Khare 2015-09-21 This book covers both the mathematics of inverse problems and optical systems design, and includes a review of the mathematical methods and Fourier optics. The first part of the book deals with the mathematical tools in detail with minimal assumption about prior knowledge on the part of the reader. The second part of the book discusses concepts in optics, particularly propagation of optical waves and coherence properties of optical fields that form the basis of the computational models used for image recovery. The third part provides a discussion of specific imaging systems that illustrate the power of the hybrid computational imaging model in enhancing imaging performance. A number of exercises are provided for readers to develop further understanding of computational imaging. While the focus of the book is largely on optical imaging systems, the key concepts are discussed in a fairly general manner so as to provide useful background for understanding the mechanisms of a diverse range of imaging modalities.

Inverse Theory and Applications in Geophysics Michael S. Zhdanov 2015-07-15 Geophysical Inverse Theory and Applications, Second Edition, brings together fundamental results developed by the Russian mathematical school in regularization theory and

combines them with the related research in geophysical inversion carried out in the West. It presents a detailed exposition of the methods of regularized solution of inverse problems based on the ideas of Tikhonov regularization, and shows the different forms of their applications in both linear and nonlinear methods of geophysical inversion. It's the first book of its kind to treat many kinds of inversion and imaging techniques in a unified mathematical manner. The book is divided in five parts covering the foundations of the inversion theory and its applications to the solution of different geophysical inverse problems, including potential field, electromagnetic, and seismic methods. Unique in its focus on providing a link between the methods used in gravity, electromagnetic, and seismic imaging and inversion, it represents an exhaustive treatise on inversion theory. Written by one of the world's foremost experts, this work is widely recognized as the ultimate researcher's reference on geophysical inverse theory and its practical scientific applications. Presents state-of-the-art geophysical inverse theory developed in modern mathematical terminology—the first to treat many kinds of inversion and imaging techniques in a unified mathematical way. Provides a critical link between the methods used in gravity, electromagnetic, and seismic imaging and inversion, and represents an exhaustive treatise on geophysical inversion theory. Features more than 300 illustrations, figures, charts and graphs to underscore key concepts. Reflects the latest developments in inversion theory and applications and captures the most significant changes in the field over the past decade.

Inverse Problem Theory and Methods for Model Parameter Estimation Albert Tarantola 2005-01-01 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.

Comprehensive Electrocardiology Peter W. Macfarlane 2010-11-05 New edition of the classic complete reference book for cardiologists and trainee cardiologists on the theory and practice of electrocardiography, one of the key modalities used for evaluating cardiology patients and deciding on appropriate management strategies.

An Introduction to the Mathematical Theory of Inverse Problems Andreas Kirsch 1996-09-26 Following Keller [119] we call two problems inverse to each other if the formulation of each of them requires full or partial knowledge of the other. By this definition, it is obviously arbitrary which of the two problems we call the direct and which we call the inverse problem. But usually, one of the problems has been studied earlier and, perhaps, in more detail. This one is usually called the direct problem, whereas the other is the inverse problem. However, there is often another, more important difference between these two problems. Hadamard (see [91]) introduced the concept of a well-posed problem, originating from the philosophy that the mathematical model of a physical problem has to have the properties of uniqueness, existence, and stability of the solution. If one of the properties fails to

hold, he called the problem ill-posed. It turns out that many interesting and important inverse in science lead to ill-posed problems, while the corresponding direct problems are well-posed. Often, existence and uniqueness can be forced by enlarging or reducing the solution space (the space of "models"). For restoring stability, however, one has to change the topology of the spaces, which is in many cases impossible because of the presence of measurement errors. At first glance, it seems to be impossible to compute the solution of a problem numerically if the solution of the problem does not depend continuously on the data, i. e. , for the case of ill-posed problems.

Discrete Inverse Problems Per Christian Hansen 2010 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.

Handbook of Mathematical Methods in Imaging Otmar Scherzer 2010-11-23 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.

Introduction to Inverse Problems in Imaging, Mario Bertero 1998-01-01 This is a graduate textbook on the principles of linear inverse problems, methods of their approximate solution and practical application in imaging. The level of mathematical treatment is kept as low as possible to make the book suitable for a wide range of readers from different backgrounds in science and engineering. Mathematical prerequisites are first courses in analysis, geometry, linear algebra, probability theory and Fourier analysis. The authors concentrate on presenting easily implementable and fast solution algorithms. The book will provide the reader with the appropriate background for a clear understanding of the essence of inverse problems (ill-posedness and its cure) and, consequently, for an intelligent assessment of the rapidly growing literature on these problems.

An Introduction to Inverse Scattering and Inverse Spectral Problems Khosrow Chadan 1997-01-01 Here is a clearly written introduction to three central areas of inverse problems: inverse problems in electromagnetic scattering theory, inverse spectral theory, and inverse problems in quantum scattering theory. Inverse problems, one of the most attractive parts of applied mathematics, attempt to obtain information about structures by nondestructive measurements. Based on a series of lectures presented by three of the authors, all experts in the field, the book provides a quick and easy way for readers to become familiar with the area through a survey of recent developments in inverse spectral and inverse scattering problems.

Inverse Imaging with Poisson Data Mario Bertero 2018-12-27 Inverse Imaging with Poisson Data is an invaluable resource for

graduate students, postdocs and researchers interested in the application of inverse problems to the domains of applied sciences, such as microscopy, medical imaging and astronomy. The purpose of the book is to provide a comprehensive account of the theoretical results, methods and algorithms related to the problem of image reconstruction from Poisson data within the framework of the maximum likelihood approach introduced by Shepp and Vardi.

An Introduction to Data Analysis and Uncertainty Quantification for Inverse Problems Luis Tenorio 2017-07-06 Inverse problems are found in many applications, such as medical imaging, engineering, astronomy, and geophysics, among others. To solve an inverse problem is to recover an object from noisy, usually indirect observations. Solutions to inverse problems are subject to many potential sources of error introduced by approximate mathematical models, regularization methods, numerical approximations for efficient computations, noisy data, and limitations in the number of observations; thus it is important to include an assessment of the uncertainties as part of the solution. Such assessment is interdisciplinary by nature, as it requires, in addition to knowledge of the particular application, methods from applied mathematics, probability, and statistics. This book bridges applied mathematics and statistics by providing a basic introduction to probability and statistics for uncertainty quantification in the context of inverse problems, as well as an introduction to statistical regularization of inverse problems. The author covers basic statistical inference, introduces the framework of ill-posed inverse problems, and explains statistical questions that arise in their applications. An Introduction to Data Analysis and Uncertainty Quantification for Inverse Problems includes many examples that explain techniques which are useful to address general problems arising in uncertainty quantification, Bayesian and non-Bayesian statistical methods and discussions of their complementary roles, and analysis of a real data set to illustrate the methodology covered throughout the book.

Wavelets Jean-Michel Combes 2012-12-06 The last two subjects mentioned in the title "Wavelets, Time Frequency Methods and Phase Space" are so well established that they do not need any explanations. The first is related to them, but a short introduction is appropriate since the concept of wavelets emerged fairly recently. Roughly speaking, a wavelet decomposition is an expansion of an arbitrary function into smooth localized contributions labeled by a scale and a position parameter. Many of the ideas and techniques related to such expansions have existed for a long time and are widely used in mathematical analysis, theoretical physics and engineering. However, the rate of progress increased significantly when it was realized that these ideas could give rise to straightforward calculational methods applicable to different fields. The interdisciplinary structure (R.C.P. "Ondelettes") of the C.N.R.S. and help from the Societe Nationale Elf-Aquitaine greatly fostered these developments. The conference, the proceedings of which are contained in this volume, was held at the Centre National de Rencontres Mathematiques (C.N.R.M) in Marseille from December 14-18, 1987 and brought together an interdisciplinary mix of participants. We hope that these proceedings will convey to the reader some of the excitement and flavor of the meeting.

Computational Methods for Inverse Problems Curtis R. Vogel 2002 Provides a basic understanding of both the underlying

mathematics and the computational methods used to solve inverse problems.

Mathematical Modelling Seppo Pohjolainen 2016-07-14 This book provides a thorough introduction to the challenge of applying mathematics in real-world scenarios. Modelling tasks rarely involve well-defined categories, and they often require multidisciplinary input from mathematics, physics, computer sciences, or engineering. In keeping with this spirit of modelling, the book includes a wealth of cross-references between the chapters and frequently points to the real-world context. The book combines classical approaches to modelling with novel areas such as soft computing methods, inverse problems, and model uncertainty. Attention is also paid to the interaction between models, data and the use of mathematical software. The reader will find a broad selection of theoretical tools for practicing industrial mathematics, including the analysis of continuum models, probabilistic and discrete phenomena, and asymptotic and sensitivity analysis.

An Introduction to Inverse Problems Jorge P. Zubelli 1999

Computational Methods for Electromagnetic Inverse Scattering Xudong Chen 2018-07-18 A comprehensive and updated overview of the theory, algorithms and applications of for electromagnetic inverse scattering problems Offers the recent and most important advances in inverse scattering grounded in fundamental theory, algorithms and practical engineering applications Covers the latest, most relevant inverse scattering techniques like signal subspace methods, time reversal, linear sampling, qualitative methods, compressive sensing, and noniterative methods Emphasizes theory, mathematical derivation and physical insights of various inverse scattering problems Written by a leading expert in the field

Iterative Optimization in Inverse Problems Charles L. Byrne 2014-02-12 Iterative Optimization in Inverse Problems brings together a number of important iterative algorithms for medical imaging, optimization, and statistical estimation. It incorporates recent work that has not appeared in other books and draws on the author's considerable research in the field, including his recently developed class of SUMMA algorithms. Related to sequential unconstrained minimization methods, the SUMMA class includes a wide range of iterative algorithms well known to researchers in various areas, such as statistics and image processing. Organizing the topics from general to more specific, the book first gives an overview of sequential optimization, the subclasses of auxiliary-function methods, and the SUMMA algorithms. The next three chapters present particular examples in more detail, including barrier- and penalty-function methods, proximal minimization, and forward-backward splitting. The author also focuses on fixed-point algorithms for operators on Euclidean space and then extends the discussion to include distance measures other than the usual Euclidean distance. In the final chapters, specific problems illustrate the use of iterative methods previously discussed. Most chapters contain exercises that introduce new ideas and make the book suitable for self-study. Unifying a variety of seemingly disparate algorithms, the book shows how to derive new properties of algorithms by comparing known properties of other algorithms. This unifying approach also helps researchers—from statisticians working on parameter estimation to image scientists processing scanning data to mathematicians involved in theoretical and applied

optimization—discover useful related algorithms in areas outside of their expertise.

The Radon Transform Ronny Ramlau 2019-06-17 In 1917, Johann Radon published his fundamental work, where he introduced what is now called the Radon transform. Including important contributions by several experts, this book reports on groundbreaking developments related to the Radon transform throughout these years, and also discusses novel mathematical research topics and applications for the next century.