
A Geophysical Inverse Theory Primer Andy Ganse

Introduction to Seismic Inversion Methods

Basics, Theory and Applications in Geophysics

An Introduction to Geophysical Exploration

The Solid Earth

Near-Surface Applied Geophysics

Geophysical Inversion Theory and Global Optimization Methods

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Theory and Practice
Inverse Theory and Applications in Geophysics
Inverse Acoustic and Electromagnetic Scattering Theory
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Introduction to Seismic Inversion

Methods Academic Press

This book provides an introductory-level exploration of geophysical fluid dynamics (GFD), the principles governing air and water flows on large terrestrial scales. Physical principles are illustrated with the aid of the simplest existing models, and the computer methods are shown in juxtaposition with the equations to which they apply. It

explores contemporary topics of climate dynamics and equatorial dynamics, including the Greenhouse Effect, global warming, and the El Nino Southern Oscillation. Combines both physical and numerical aspects of geophysical fluid dynamics into a single affordable volume. Explores contemporary topics such as the Greenhouse Effect, global warming and the El Nino Southern Oscillation. Biographical and historical notes at the ends of chapters trace the intellectual development of the field. Recipient of the 2010 Wernaers Prize, awarded each year by the National Fund for Scientific

Research of Belgium (FNR-FNRS).

Basics, Theory and Applications in Geophysics Cambridge University Press

This book addresses the problem of inferring the state of the ocean circulation, from a mathematical perspective.

An Introduction to Geophysical Exploration Cambridge University Press

Geophysical inversion is an ill-posed problem. Classical local search method for inversion is depend on initial guess and easy to be trapped in local optimum. The global optimization is a group of novel methods to deal with the problems mentioned above. The book introduces the geophysical inversion theory, including the classical solving approaches firstly. Then, it introduces several typical global inversion

approaches including particle swarm optimization (PSO), differential evolution (DE), and multiobjective optimization methods, as well as some examples to inverse the geophysical data, such as gravity, MT sounding, well logging, self-potential, seismic data, using these global optimization approaches.

The Solid Earth Springer Science & Business Media

In many physical sciences, the most natural description of a system is with a function of position or time. In principle, infinitely many numbers are needed to specify that function, but in practice only finitely many measurements can be made. Inverse theory concerns the mathematical techniques that enable researchers to use the available information to build a model of the

unknown system or to determine its essential properties. In Geophysical Inverse Theory, Robert Parker provides a systematic development of inverse theory at the graduate and professional level that emphasizes a rigorous yet practical solution of inverse problems, with examples from experimental observations in geomagnetism, seismology, gravity, electromagnetic sounding, and interpolation. Although illustrated with examples from geophysics, this book has broad implications for researchers in applied disciplines from materials science and engineering to astrophysics, oceanography, and meteorology. Parker's approach is to avoid artificial statistical constructs and to emphasize instead the reasonable assumptions

researchers must make to reduce the ambiguity that inevitably arises in complex problems. The structure of the book follows a natural division in the subject into linear theory, in which the measured quantities are linear functionals of the unknown models, and nonlinear theory, which covers all other systems but is not nearly so well understood. The book covers model selection as well as techniques for drawing firm conclusions about the earth independent of any particular model.

Near-Surface Applied Geophysics

Academic Press

Extracting information from seismic data requires knowledge of seismic wave propagation and reflection. The commonly used method involves solving linearly for a reflectivity at every point

within the Earth, but this book follows an alternative approach which invokes inverse scattering theory. By developing the theory of seismic imaging from basic principles, the authors relate the different models of seismic propagation, reflection and imaging - thus providing links to reflectivity-based imaging on the one hand and to nonlinear seismic inversion on the other. The comprehensive and physically complete linear imaging foundation developed presents new results at the leading edge of seismic processing for target location and identification. This book serves as a fundamental guide to seismic imaging principles and algorithms and their foundation in inverse scattering theory, and is a valuable resource for working geoscientists, scientific programmers

and theoretical physicists.

Geophysical Inversion Theory and Global Optimization Methods Princeton University Press

In this book the author presents the state-of-the-art electromagnetic (EM) theories and methods employed in EM geophysical exploration. The book brings together the fundamental theory of EM fields and the practical aspects of EM exploration for mineral and energy resources. This text is unique in its breadth and completeness in providing an overview of EM geophysical exploration technology. The book is divided into four parts covering the foundations of EM field theory and its applications, and emerging geophysical methods. Part I is an introduction to the field theory required for baseline

understanding. Part II is an overview of all the basic elements of geophysical EM theory, from Maxwell's fundamental equations to modern methods of modeling the EM field in complex 3-D geo-electrical formations. Part III deals with the regularized solution of ill-posed inverse electromagnetic problems, the multidimensional migration and imaging of electromagnetic data, and general interpretation techniques. Part IV describes major geophysical electromagnetic methods—direct current (DC), induced polarization (IP), magnetotelluric (MT), and controlled-source electromagnetic (CSEM) methods—and covers different applications of EM methods in exploration geophysics, including minerals and HC exploration,

environmental study, and crustal study.

* Presents theoretical and methodological findings, as well as examples of applications of recently developed algorithms and software in solving practical problems * Describes the practical importance of electromagnetic data through enabling discussions on a construction of a closed technological cycle, processing, analysis and three-dimensional interpretation * Updates current findings in the field, especially with MT, magnetovariational and seismo-electrical methods and the practice of 3D interpretations
Insight and Algorithms SIAM

A fully up-dated edition of this acclaimed undergraduate geophysics textbook.
Global Optimization Methods in Geophysical Inversion John Wiley & Sons

This new edition of the well-established Kearey and Brooks text is fully updated to reflect the important developments in geophysical methods since the production of the previous edition. The broad scope of previous editions is maintained, with even greater clarity of explanations from the revised text and extensively revised figures. Each of the major geophysical methods is treated systematically developing the theory behind the method and detailing the instrumentation, field data acquisition techniques, data processing and interpretation methods. The practical application of each method to such diverse exploration applications as petroleum, groundwater, engineering, environmental and forensic is shown by case histories. The mathematics

required in order to understand the text is purposely kept to a minimum, so the book is suitable for courses taken in geophysics by all undergraduate students. It will also be of use to postgraduate students who might wish to include geophysics in their studies and to all professional geologists who wish to discover the breadth of the subject in connection with their own work.

Theory and Applications Elsevier

The magnetotelluric method is a technique for imaging the electrical conductivity and structure of the Earth, from the near surface down to the 410 km transition zone and beyond. This book forms the first comprehensive overview of magnetotellurics from the salient physics and its mathematical

representation, to practical implementation in the field, data processing, modeling and geological interpretation. Electromagnetic induction in 1-D, 2-D and 3-D media is explored, building from first principles, and with thorough coverage of the practical techniques of time series processing, distortion, numerical modeling and inversion. The fundamental principles are illustrated with a series of case histories describing geological applications. Technical issues, instrumentation and field practices are described for both land and marine surveys. This book provides a rigorous introduction to magnetotellurics for academic researchers and advanced students and will be of interest to industrial practitioners and geoscientists

wanting to incorporate rock conductivity into their interpretations.

Theory and Practice Elsevier

It has now been almost ten years since our first book on scattering theory appeared [32]. At that time we claimed that "in recent years the development of integral equation methods for the direct scattering problem seems to be nearing completion, whereas the use of such an approach to study the inverse scattering problem has progressed to an extent that a 'state of the art' survey appears highly desirable". Since we wrote these words, the inverse scattering problem for acoustic and electromagnetic waves has grown from being a few theoretical considerations with limited numerical implementations to a well developed mathematical theory with tested

numerical algorithms. This maturing of the field of inverse scattering theory has been based on the realization that such problems are in general not only nonlinear but also improperly posed in the sense that the solution does not depend continuously on the measured data. This was emphasized in [32] and treated with the ideas and tools available at that time. Now, almost ten years later, these initial ideas have developed to the extent that a monograph summarizing the mathematical basis of the field seems appropriate. This book is an attempt to write such a monograph. The inverse scattering problem for acoustic and electromagnetic waves can broadly be divided into two classes, the inverse obstacle problem and the inverse

medium problem.

Potential Theory in Applied Geophysics
Cambridge University Press

This book introduces the principles of gravitational, magnetic, electrostatic, direct current electrical and electromagnetic fields, with detailed solutions of Laplace and electromagnetic wave equations by the method of separation of variables. Discussion includes behaviours of the scalar and vector potential and the nature of the solutions of these boundary value problems, along with the use of complex variables and conformal transformation, Green's theorem, Green's formula and Green's functions.

Integrated Imaging of the Earth

SIAM

An overview of the current techniques

used in the inversion of seismic data is provided. Inversion is defined as mapping the physical structure and properties of the subsurface of the earth using measurements made on the surface, creating a model of the earth using seismic data as input.

Inverse Problem Theory and Methods for Model Parameter

Estimation Cambridge University Press
Preface -- 1. Introduction -- 2. Linear Regression -- 3. Discretizing Continuous Inverse Problems -- 4. Rank Deficiency and Ill-Conditioning -- 5. Tikhonov Regularization -- 6. Iterative Methods -- 7. Other Regularization Techniques -- 8. Fourier Techniques -- 9. Nonlinear Regression -- 10. Nonlinear Inverse Problems -- 11. Bayesian Methods -- Appendix A: Review of Linear Algebra --

Appendix B: Review of Probability and Statistics -- Appendix C: Glossary of Notation -- Bibliography -- Index
Linear Regression -- Discretizing Continuous Inverse Problems -- Rank Deficiency and Ill-Conditioning -- Tikhonov Regularization -- Iterative Methods -- Other Regularization Techniques -- Fourier Techniques -- Nonlinear Regression -- Nonlinear Inverse Problems -- Bayesian Methods.

Discrete Inverse Theory World Scientific

Reliable and detailed information about the Earth's subsurface is of crucial importance throughout the geosciences. Quantitative integration of all available geophysical and geological data helps to make Earth models more robust and reliable. The aim of this book is to

summarize and synthesize the growing literature on combining various types of geophysical and other geoscientific data. The approaches that have been developed to date encompass joint inversion, cooperative inversion, and statistical post-inversion analysis methods, each with different benefits and assumptions. Starting with the foundations of inverse theory, this book systematically describes the mathematical and theoretical aspects of how to best integrate different geophysical datasets with geological prior understanding and other complimentary data. This foundational basis is followed by chapters that demonstrate the diverse range of applications for which integrated methods have been used to date. These

range from imaging the hydrogeological properties of the near-surface to natural resource exploration and probing the composition of the lithosphere and the deep Earth. Each chapter is written by leading experts in the field, which makes this book the definitive reference on integrated imaging of the Earth. Highlights of this volume include: Complete coverage of the theoretical foundations of integrated imaging approaches from inverse theory to different coupling methods and quantitative evaluation of the resulting models Comprehensive overview of current applications of integrated imaging including hydrological investigations, natural resource exploration, and imaging the deep Earth Detailed case studies of integrated

approaches providing valuable guidance for both experienced users and researchers new to joint inversion. This volume will be a valuable resource for graduate students, academics, industry practitioners, and researchers who are interested in using or developing integrated imaging approaches.

SIAM

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.

An Introduction to the Mathematical Theory of Inverse Problems Cambridge University Press

This book provides an up-to-date presentation of a broad range of contemporary problems in inverse scattering involving acoustic, elastic and electromagnetic waves. Descriptions will be given of traditional (but still in use and subject to on-going improvements) and more recent methods for identifying either: a) the homogenized material parameters of (spatially) unbounded or bounded heterogeneous media, or b) the detailed composition (spatial distribution of the material parameters) of unbounded or bounded heterogeneous media, or c) the location, shape, orientation and material characteristics of an object embedded in a wellcharacterized homogeneous, homogenized or heterogeneous unbounded or bounded medium, by

inversion of reflected, transmitted or scattered spatiotemporal recorded waveforms resulting from the propagation of probe radiation within the medium.

Introduction to Geophysical Fluid Dynamics Springer Science & Business Media

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.

Seismic Inversion Academic Press
Innovation in Near-Surface Geophysics:

Instrumentation, Application, and Data Processing Methods offers an advanced look at state-of-the-art and innovative technologies for near surface geophysics, exposing the latest, most effective techniques in an accessible way. By addressing a variety of geophysical applications, including cultural heritage, civil engineering, characteristics of soil, and others, the book provides an understanding of the best products and methodologies modern near surface geophysics has to offer. It proposes tips for new ideas and projects, and encourages collaboration across disciplines and techniques for the best implementation and results. Clearly organized, with contributions from leaders from throughout geophysics, Innovation in Near-Surface Geophysics is

an important guide for geophysicists who hope to gain a better understanding of the tools and techniques available. Addresses a variety of applications in near-surface geophysics, including cultural heritage, civil engineering, soil analysis, etc. Provides insight to available products and techniques and offers suggestions for future developments Clearly organized by techniques and their applications

Inverse Methods for Atmospheric Sounding SIAM

This collection of papers on geophysical inversion contains research and survey articles on where the field has been and where it's going, and what is practical and what is not. Topics covered include seismic tomography, migration and inverse scattering.

Data Assimilation: Methods, Algorithms, and Applications Elsevier

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.

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