

BOOK REVIEW

Book Review: *Geophysical Data Analysis: Discrete Inverse Theory (MATLAB Edition)*, Third edition. By William Menke. (2012) Academic Press/Elsevier, 330 p. \$88.95 ebook, ISBN: 978-0-12-397160-9.

I eagerly awaited the arrival of the third edition of *Geophysical Data Analysis* on my desk, as an earlier edition of the book is a well-used mainstay of my reference shelf. This invaluable book contains a complete yet concise introduction to inverse theory from a geophysical perspective, and is widely used both as graduate-level textbook and as a reference for practicing geoscientists. The author is Professor of Earth and Environmental Sciences at Lamont-Doherty Earth Observatory, Columbia University, and has published extensively on observational and theoretical seismology, inverse problems, and data analysis.

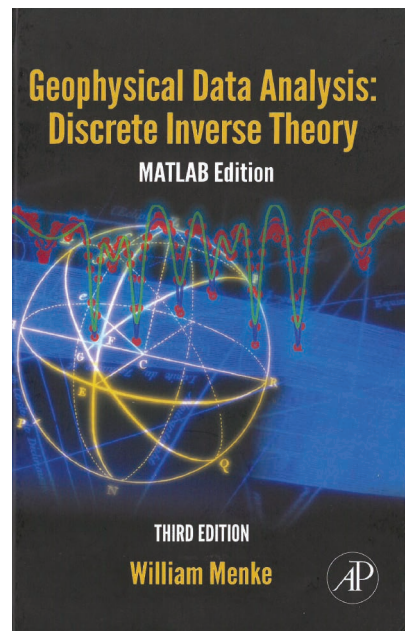
The book represents a wide-ranging overview of discrete inverse theory at a level of mathematical rigor that is sufficient to communicate the concepts, but avoids getting bogged down in detail. Early chapters cover an overview of inverse problems and their description, a brief treatment of probability theory, and a detailed discussion of the solution of linear, Gaussian inverse problems. Later chapters introduce maximum likelihood methods, vector spaces, and non-Gaussian statistics in linear inverse problems. Towards the end of the book, there is a discussion of nonlinear inverse problems and model space search approaches, factor analysis, tomography (introduced by a brief discussion of continuous inverse problems), sample inverse problems, and finally applications of inverse theory to solid Earth geophysics, the author's specialty. In its scope the new edition covers much the same ground as earlier editions, with some additions—new material on Fréchet derivatives, adjoint methods, and seismic waveform tomography particularly caught my eye—but the figures have been completely updated, with the Matlab scripts used to draft the figures typically included.

The most exciting innovation in the new edition is, as the title suggests, the addition of an accompanying set of Matlab scripts that are used to illustrate concepts and implement many of the examples discussed in the text. The website accompanying the book includes dozens of Matlab scripts for download (as well as PowerPoint slides that are useful for teaching). These range from simple scripts that illustrate basic syntax and usage in Matlab to more complicated codes that, for example, compute sensitivity kernels for acoustic wave propagation or implement a simulated annealing algorithm for a nonlinear curve-fitting problem. Another excellent addition to the new edition is the inclusion

of problems at the end of each chapter, most of which involve writing code or modifying the provided scripts. The inclusion of the Matlab-based problems and example scripts enhances the book's utility as a teaching and learning tool for practicing researchers and students alike. While the book does not contain an exhaustive guide to Matlab, it does provide a brief and very useful tutorial in the introduction; for

new users, this tutorial (perhaps in combination with an introductory Matlab textbook) should be enough to get off the ground.

Geophysical Data Analysis is both an excellent reference for practicing scientists and a clear, thorough, and practical textbook for an inverse theory course at the graduate or advanced undergraduate level. As Menke points out in the book's preface, every scientist who has used data to make inferences about how the Earth works has practiced inverse theory; while the book is written from the perspective of a solid Earth geophysicist, it will be useful to scientists across a range of geoscience disciplines. The breadth of material covered in the text is impressive, and the book strikes a good balance between completeness and conciseness. The third edition of *Geophysical Data Analysis* represents a valuable update to one of the definitive textbooks on inverse theory for geoscience applications, and I highly recommend both the book itself and the accompanying Matlab code resources.



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