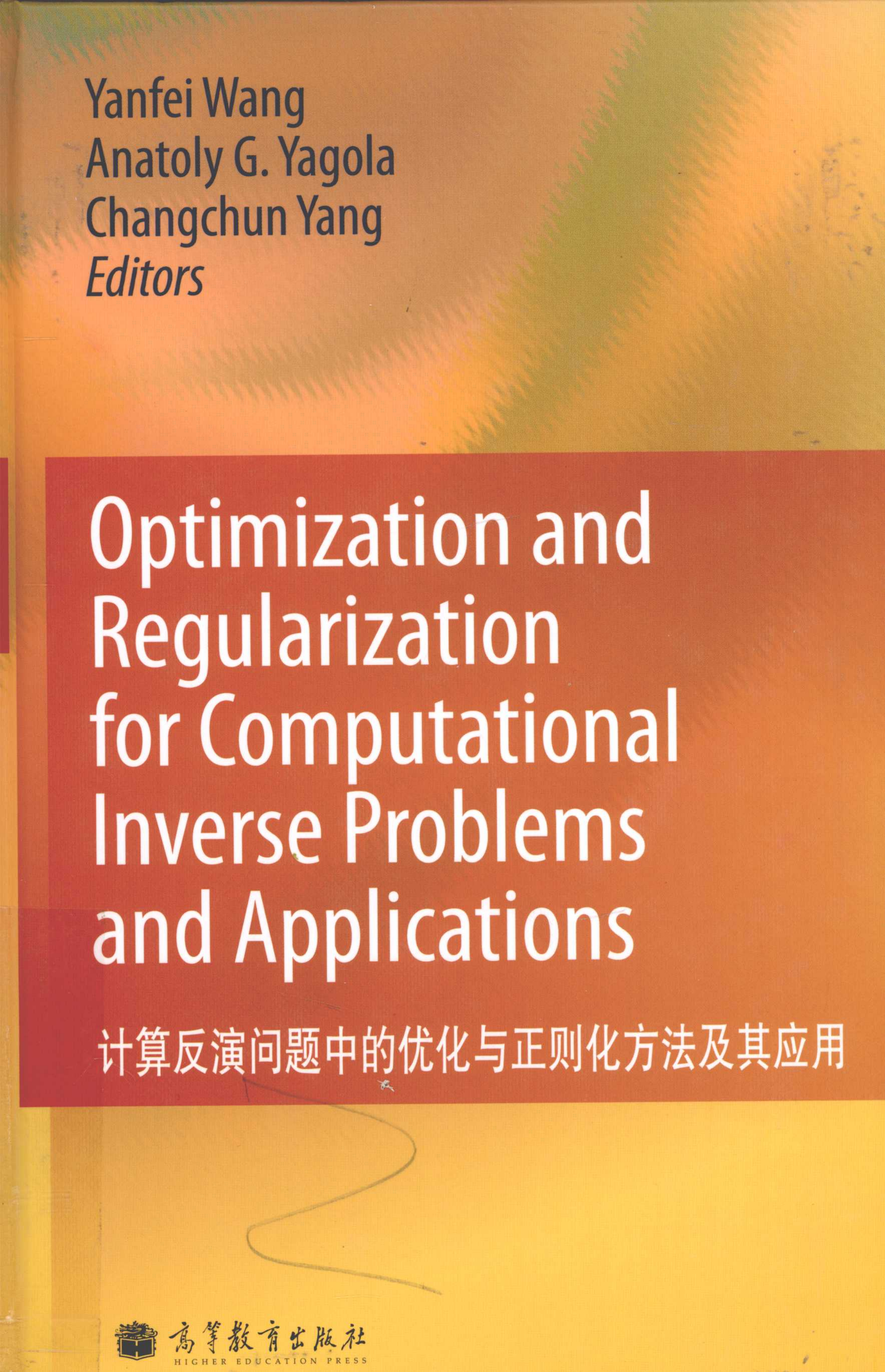

Yanfei Wang
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Editors

Optimization and Regularization for Computational Inverse Problems and Applications

计算反演问题中的优化与正则化方法及其应用

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With 41 figures

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Yanfei Wang
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Optimization and Regularization for Computational Inverse Problems and Applications

Preface by Anatoly G. Yagola

This volume contains the papers presented by invited speakers of the first international workshop "Optimization and Regularization for Computational Inverse Problems and Applications". The workshop was organized under the auspices of the Chinese Academy of Sciences in the Institute of Geology and Geophysics, located in Beijing, the capital of China, and held during July 21–25, 2008, just before the opening of the Olympic Games. The workshop was sponsored by the National Natural Science Foundation of China, China-Russia Cooperative Research Project RFBR-07-01-92103-NFSC and the National "973" Key Basic Research Developments Program of China. The main goal of the workshop was to teach about 60 young Chinese participants (mostly geophysicists) how to solve inverse and ill-posed problems using optimization procedures. Eminent specialists from China, Russia (partially sponsored by the Russian Foundation of Basic Research), USA and Austria were invited to present their lectures. Some of them could not participate personally but all invited speakers found a possibility to write papers especially for this publication.

The book covers many directions in the modern theory of inverse and ill-posed problems – the variational approach, iterative methods, using *a priori* information for constructing regularizing algorithms, etc. But the most important for the papers is to show how these methods can be applied to effectively solving of practical problems in geophysics, astrophysics, vibrational spectroscopy, and image processing. This issue should encourage specialists in the inverse problems field not only to investigate mathematical methods and propose new approaches but also to apply them to processing of real experimental data. I would like to wish all of them great successes!

Lomonosov Moscow State University
Moscow, Russia
March 2010

Anatoly G. Yagola

Preface by Editors

The field of inverse problems has existed in many branches of physics, earth science, engineering and mathematics for a long time. From the beginning of the birth of the inversion theory, inverse problem with its modeling design and optimization becomes a multi-disciplinary subject, which has received much more attention nowadays. The aim of the inverse problems, modeling design and optimization is to provide a better, more accurate, and more efficient simulation in practical applications. Many methodologies for solving inverse problems employs optimization algorithms. At the same time, optimization community that employ methods of inverse modeling design could reduce the number of time-consuming analyses required by the typical optimization algorithms substantially. This book provides readers who do research in computational/applied mathematics, engineering, geophysics, medical science, image processing, remote sensing and atmospheric science a background of using regularization and optimization techniques for solving practical inverse problems.

The book covers advances of inversion theory and recent developments with practical applications. Particularly, it emphasizes combining optimization and regularization for solving inverse problems. The methods include standard regularization theory, Fejér processes for linear and nonlinear problems, balancing principle, extrapolated regularization, nonstandard regularization, nonlinear gradient method, nonmonotone (Barzilai-Borwein) method, subspace method and Lie group method. The practical applications include reconstruction problem for inverse scattering, molecular spectra data processing, quantitative remote sensing inversion, seismic inversion by Lie group method and gravitational lensing problem.

Uniqueness of this book is that it provides novel methods for both standard and nonstandard regularization and practical applications in frontiers of sciences. Each chapter is written by renown researchers in their research field respectively. Illustrations and tables are provided for better understanding of their ideas. Scientists, researchers, engineers and as well as graduate students engaged in applied mathematics, engineering, geophysics, medical science, image processing, remote sensing and atmospheric science will benefit from the contents of the book since the book incorporates a background of using regularization and optimization techniques for solving practical inverse problems.

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May 2010

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Part I
Introduction