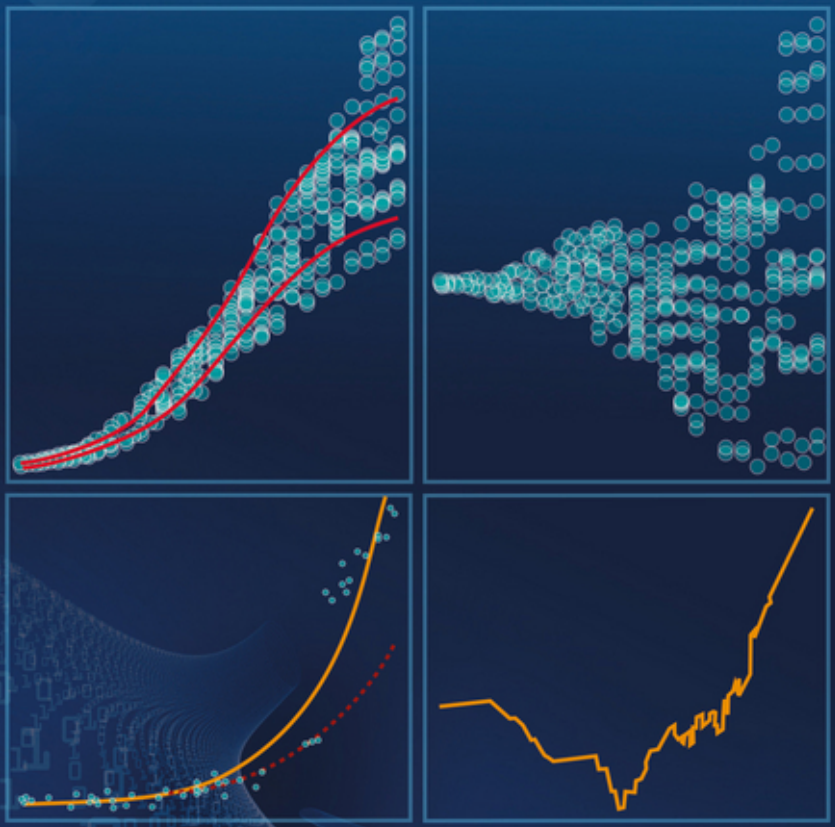
Robust Nonlinear Regression

with Applications using R



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This edition first published 2019

Registered Offices
John Wiley & Sons, Inc., 111 River Street, Hoboken, NJ 07030, USA
John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, UK

Editorial Office
9600 Garsington Road, Oxford, OX4 2DQ, UK

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Library of Congress Cataloging-in-Publication Data

Names: Riazoshams, Hossein, 1971– author. | Midi, Habshah, author. | Ghilagaber, Gebrenegus, author.
Title: Robust nonlinear regression: with applications using R / Hossein Riazoshams, Habshah Midi, Gebrenegus Ghilagaber.
Description: Hoboken, NJ : John Wiley & Sons, 2018. | Includes bibliographical references and index. |
Identifiers: LCCN 2017057347 (print) | LCCN 2018005931 (ebook) | ISBN 9781119010456 (pdf) | ISBN 9781119010449 (epub) | ISBN 9781118738061 (cloth)
Subjects: LCSH: Regression analysis. | Nonlinear theories. | R (Computer program language)
Classification: LCC QA278.2 (ebook) | LCC QA278.2 .R48 2018 (print) | DDC 519.5/36–dc23
LC record available at https://lccn.loc.gov/2017057347

Cover Design: Wiley
Cover Image: © Wavebreakmedia Ltd/Getty Images; © Courtesy of Hossein Riazoshams

Set in 10/12pt WarnockPro by SPi Global, Chennai, India

10 9 8 7 6 5 4 3 2 1

To my wife Benchamat Hanchana, from Hossein

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Preface

This book is the result of the first author's research, between 2004 and 2016, in the robust nonlinear regression area, when he was affiliated with the institutions listed. The lack of computer programs together with mathematical development in this area encouraged us to write this book and provide an R-package called `nlr` for which a guide is provided in this book. The book concentrates more on applications and thus practical examples are presented.

Robust statistics describes the methods used when the classical assumptions of statistics do not hold. It is mostly applied when a data set includes outliers that lead to violation of the classical assumptions.

The book is divided into two parts. In Part 1, the mathematical theories of robust nonlinear regression are discussed and parameter estimation for heteroscedastic error variances, autocorrelated errors, and several methods for outlier detection are presented. Part 2 presents numerical methods and R-tools for nonlinear regression using robust methods.

In Chapter 1, the basic theories of robust statistics are discussed. Robust approaches to linear regression and outlier detection are presented. These mathematical concepts of robust statistics and linear regression are then extended to nonlinear regression in the rest of the book. Since the book is about nonlinear regression, the proofs of theorems related to robust linear regression are omitted.

Chapter 2 presents the concepts of nonlinear regression and discusses the theory behind several methods of parameter estimation in this area. The robust forms of these methods are outlined in Chapter 3. Chapter 2 presents the generalized least square estimate, which will be used for non-classical situations.

Chapter 3 discusses the concepts of robust statistics, such as robustness and breakdown points, in the context of nonlinear regression. It also presents several robust parameter estimation techniques.

Chapter 4 develops the robust methods for a null condition when the error variances are not homogeneous. Different kinds of outlier are defined and their effects are discussed. Parameter estimation for nonlinear function models and variance function models are presented.

Another null condition, when the errors are autocorrelated, is discussed in Chapter 5. Robust and classical methods for estimating the nonlinear function model and the autocorrelation structure of the error are presented. The effect of different kinds of outlier are explained, and appropriate methods for identifying the correlation structure of errors in the presence of outliers are studied.

Chapter 6 explains the methods for identifying atypical points. The outlier detection methods that are developed in this chapter are based mainly on statistical measures that use robust estimators of the parameters of the nonlinear function model.

In Chapter 7, optimization methods are discussed. These techniques are then modified to solve the minimization problems found in robust nonlinear regressions. They will then used to solve the mathematical problems discussed in Part 1 of the book and their implementation in a new R package called `nlr` is then covered in Chapter 8.

Chapter 8 is a guide to the R package implemented for this book. It covers object definition for a nonlinear function model, parameter estimation, and outlier detection for several model assumption situations discussed in the Part 1. This chapter shows how to fit nonlinear models to real-life and simulated data.

In Chapter 9, another R packages for robust nonlinear regression are presented and compared to `nlr`. Appendix A presents and describes the databases embedded in `nlr`, and the nonlinear models and functions available.

At the time of writing, the `nlr` package is complete, and is available at The Comprehensive R Archive Network (CRAN-project) at https://cran.r-project.org/package=nlr.

Because of the large number of figures and programs involved, there are many examples that could not be included in the book. Materials, programs, further examples, and a forum to share and discuss program bugs are all provided at the author's website at http://www.riazoshams.com/nlr and at the book's page on the Wiley website.

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November 2017

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Acknowledgements

I would like to thank the people and organizations who have helped me in all stages of they research that has culminated in this book. Firstly I would like to express my appreciation to Mohsen Ghodousi Zadeh and Hamid Koohbor for helping me in collecting data for the first time in 2005. This led me to a program of research in nonlinear modeling.

I would like to recognize the Department of Statistics at Stockholm University, Sweden, for financial support while writing most of this book during my stay as a post-doctoral researcher in 2012–2014.

A special note of appreciation is also due to the Islamic Azad University of Abadeh and Lamerd for financial support in connection with collecting some materials for this book.

I would like note my appreciation for the Institute for Mathematical Research of University Putra Malaysia for financial support during my PhD in 2007–2010 and afterwards.

I owe my gratitude to the John Wiley editing team, specially Shyamala and others for their great editing process during the preparation of the book.

Last but by no means least, I would like to thank my wife, Benchamat Hanchan, for her great patience with the financial and physical adversity that we experienced during this research.

November 2017 *Hossein Riazoshams*