


Preface

Regression is the most popular and commonly used statistical methodology for analyzing empirical problems in social sciences, economics, and life sciences. Correspondingly, there exist a large variety of models and inferential tools, ranging from conventional linear models to modern non- and semiparametric regression. Currently available textbooks mostly focus on particular classes of regression models, however, strongly varying in style, mathematical level, and orientation towards theory or application. Why then another book on regression? Several introductory textbooks are available for students and practitioners in diverse fields of applications, but they deal almost exclusively with linear regression. On the other hand, most texts concentrating on modern non- and semiparametric methods primarily address readers with strong theoretical interest and methodological background, presupposing a correspondingly high-level mathematical basis. They are therefore less accessible to readers from applied fields who need to employ these methods.

The aim of this book is an applied and unified introduction into parametric, non-, and semiparametric regression that closes the gap between theory and application. The most important models and methods in regression are presented on a solid formal basis, and their appropriate application is shown through many real data examples and case studies. Availability of (user-friendly) software has been a major criterion for the methods selected and presented. In our view, the interplay and balance between theory and application are essential for progress in substantive disciplines, as well as for the development of statistical methodology, motivated and stimulated through new challenges arising from multidisciplinary collaboration. A similar goal, but with somewhat different focus, has been pursued in the book *Semiparametric Regression* by Ruppert, Wand, and Carroll (2003).

Thus, our book primarily targets an audience that includes students, teachers, and practitioners in social, economic, and life sciences, as well as students and teachers in statistics programs and mathematicians and computer scientists with interests in statistical modeling and data analysis. It is written at an intermediate mathematical level and assumes only knowledge of basic probability, calculus, and statistics. Short parts in the text dealing with more complex details or providing additional information start with the symbol  and end with . These parts may be omitted in a first reading without loss of continuity. The most important definitions and


statements are concisely summarized in boxes. Two appendices describe required matrix algebra, as well as elements of probability calculus and statistical inference.

Depending on the particular interests, parts of the book can be read independently of remaining parts or also in modified order:

- Chapter 2 provides an introductory overview on parametric, non-, and semiparametric regression models, deliberately omitting technical details and inferential tools.
- Chapters 1–4 can be read as an introduction to linear models.
- Linear mixed models (Sects. 7.1–7.4) can be studied immediately after Chaps. 1–4 and before reading Chaps. 5 and 6.
- Sections 10.1 and 10.2 on linear quantile regression can be read immediately after Chaps. 1–4.
- Chapters 1–4, Sects. 7.1–7.4, and Chaps. 8–10 can be read as an introduction to parametric and semiparametric regression for continuous responses (including semiparametric quantile regression).
- Chapters 1–6 comprise parametric regression models for continuous and discrete responses.

An overview of possible reading alternatives is given in the following table (chapters in brackets [...] could be omitted):

Description	Chapters
Linear models	1, 2, 3, 4, [Sects. 10.1, 10.2]
Linear mixed models	1, 2, 3, 4, Sects. 7.1–7.4, [Sects. 10.1–10.2]
Variable selection in linear models	3, Sects. 4.2–4.4
Generalized linear models	1, 2, 3, 4, 5, [6]
Generalized linear mixed models	1, 2, 3, 4, 5, [6], 7
Semiparametric regression for continuous responses (excluding mixed models)	1, 2, 3, 4, 8 (excl. pages 481 ff.), 9 (excl. Sects. 9.4, 9.6.2), [10]
Semiparametric regression for continuous responses (including mixed models)	1, 2, 3, 4, Sects. 7.1–7.4, 8, 9, [10]

Many examples and applications from diverse fields illustrate models and methods. Most of the data sets are available via the url <http://www.regressionbook.org/> and the symbol  added to an example indicates the availability of corresponding software code from the web site. This facilitates independent work and studies through real data applications and small case studies. In addition, the web site provides information about statistical software for regression.

Highlights of the book include:

- An introduction of regression models from first principles, i.e., a complete and comprehensive introduction to the linear model in Chaps. 3, 4, and 10
- A coverage of the entire range of regression models starting with linear models, covering generalized linear and mixed models and also including (generalized) additive models and quantile regression

- A presentation of both frequentist and Bayesian approaches to regression
- The inclusion of a large number of worked out examples and case studies
- Although the book is written in textbook style suitable for students, the material is close to current research on advanced regression analysis

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