Preface

Long-memory, or more generally fractal, processes are known to play an important role in many scientific disciplines and applied fields such as physics, geophysics, hydrology, economics, finance, climatology, environmental sciences, biology, medicine, telecommunications, network engineering, to name a few. There are several reasons for the ubiquitous occurrence of processes in the realm of long memory. First of all, hyperbolic scaling occurs naturally (up to modifications by slowly varying functions) in limit theorems for partial sums, since, under very general conditions, the limiting processes are necessarily self-similar. One may in fact say that in the world of stochastic processes, self-similar processes play the same fundamental role as stable distributions (including the normal) in the world of finite-dimensional distributions. Hyperbolic scaling phenomena are also an essential ingredient in statistical physics (a related notion is, for example, the so-called renormalization group). This is, at least partially, connected with the role of self-similar processes in limit theorems. Another reason for the occurrence of long-memory phenomena is aggregation. This, together with heterogeneity, is a frequent explanation of long-range dependence in an economic context. In telecommunications and computer networks, distributional properties of waiting times can lead to similar results. Finally, there is also a connection to fractals (though not always direct, depending on more specific distributional assumptions).

Although the notion of long memory and related topics can be traced far back into the early 20th or even the late 19th century, it is probably fair to say that the subject has been brought to the attention of a wider mathematical audience (and, in particular, probabilists and statisticians) by the pioneering work of Mandelbrot and his coworkers. A similar pathbreaking role can be attributed to Granger in economics, to Dobrushin (and before, to Kolmogorov) in physics and, even earlier, to Hurst in hydrology. These early contributions motivated a number of eminent probabilists to develop a theory of stochastic processes in the realm of stochastic self-similarity, scaling laws and nonstandard limit theorems. The development of statistical methods followed. An overview of the state of the art in the early 1990s can be found, for instance, in Beran (1994a). Other books and monographs on the topic, most of them with a special focus on certain areas of application or specific methods or processes,

Since the appearance of the first monograph on statistical methods for long-memory processes in the early 1990s, there has been an enormous development. One now has a much better understanding of the probabilistic foundations and statistical principles, various new techniques have been introduced to derive limit theorems and other fundamental results, and a large variety of flexible statistical methods are now available, including parametric, nonparametric, semiparametric and adaptive inference for stationary, nonstationary, locally stationary and nonlinear processes. This book grew out of the need to summarize the main results in this rapidly expanding area. Due to the progress in the last two decades, a more systematic account of theory and methods can be given. The aim is to cover both, probabilistic and statistical aspects, in as much detail as possible (given a limited number of pages), while at the same time including a broad range of topics. Because of the enormous number of theoretical and an even more overwhelming quantity of applied papers in this area, it was not possible to include all interesting results, and we apologize in advance to all authors whose contributions we could not mention. Apart from the mathematical theory, practical aspects of data analysis are discussed and illustrated by examples from various fields of application. We hope that this book will be useful to researchers interested in mathematical aspects of long-memory processes as well as to readers whose focus is on practical data analysis.

We would like to thank Todd Mitchell (JISAO, University of Washington) for the Sahel rainfall index series (data source: National Oceanic and Atmospheric Administration Global Historical Climatology Network (version 2), at the National Climatic Data Center of NOAA), the Federal Office of the Environment (FOEN), Switzerland and Hintermann & Weber, AG, Switzerland, for the species count data, to Giovanni Galizia and Martin Strauch (Department of Biology, University of Konstanz) for calcium imaging data, and to Bimal Roy and Sankhya, B, for the permission to reproduce figures from Ghosh (2009). Also, other online data bases where time series are available for free download are gratefully acknowledged, including in particular R.J. Hyndman’s Time Series Data Library; the River Discharge Database of The Center of Sustainability and Global Environment, Gaylord Nelsen Institute for Environmental Studies, University of Wisconsin-Madison; the Climate Explorer of the Royal Netherlands Meteorological Institute; the Physionet databank funded by the National Institute of Health; the NASA Ozone Processing Team.

J.B. would like to thank the University of Konstanz for granting him a sabbatical with the sole purpose of working on this book and Paul Embrechts and colleagues at RiskLab (ETH) for their hospitality during that sabbatical. Thanks go in particular to Bikram Das, Marius Hofert, Georg Mainik, Artem Sapozhnikov, Alain-Sol Sznitman, Hans Herrmann and Paul Embrechts for stimulating discussions; to Martin Schützner, Dieter Schell, Yevgen Shumeyko, Arno Weiershäuser and Dirk Ocker for years of fruitful collaboration; and to Volker Bürkel for reading parts of a preliminary manuscript.
Y.F. would like to thank the University of Paderborn and the Faculty of Business Administration and Economics for great support. In particular, the Faculty of Business Administration and Economics kindly provided the financial support for an additional 3-year assistant position for supporting teaching at the Professorship of Econometrics and Quantitative Methods of Empirical Economic Research, so that Y.F. could pay more attention to writing this book. Some Ph.D. students and students in the research group have helped by collecting and handling some related data. Special thanks go to colleagues from the Department of Economics and the Center of International Economics, in particular, Thomas Gries and Manfred Kraft, for collaboration, helpful discussions and support.

S.G. would like to thank the Forest Resources and Management unit of the WSL for unstinting support and the colleagues from the WSL IT unit for seeing through that the computing jobs ran without a glitch. Swiss National Science Foundation funded two 3-year projects in the domain of climate change, supporting Ph.D. students. Substantive collaboration with Christoph Frei, ETH Zurich and MeteoSwiss, Switzerland, on Swiss precipitation dynamics, Brigitta Amman, Willy Tinner (palaeoecology) and Jakob Schwander (physics), University of Bern, on statistical topics related to rapid climate change, and background information and data on vascular plant species richness in Switzerland provided by Matthias Plattner, Hintermann and Weber, AG, Switzerland, and Federal Office of the Environment, Switzerland, are gratefully acknowledged. Additional thanks go to her former students Dana Draghicescu, Patricia Menéndez and Hesam Montazeri for many hours of interesting discussions and joint work, the Statistics groups at ETH Zurich and EPF Lausanne, in particular, Stefan Morgenthaler, Hans Künsch and Werner Stahel for collegiality and collaboration, and Otto Wildi, WSL, for inspirational discussions in particular during editorial collaboration on another book.

R.K. would like to thank his Ph.D. supervisor, Ryszard Szekli of the University of Wrocław, Poland, for introducing him into the world of long memory. Special thanks to Raluca Balan, André Dabrowski and Gail Ivanoff of the University of Ottawa, and Miklós Csörgő and Barbara Szyszkowicz of Carleton University for giving him the opportunity to spend fruitful years as a postdoctoral fellow. R.K. would also like to thank Paweł Lorek, Marc Raimondo, Philippe Soulier and Cornelia Wichelhaus for fruitful collaboration in the field of long-range dependence.

We would like to thank our families for their support. J.B. and S.G. would like, in particular, to thank Céline Beran and Sir Hastings for all those long walks and some of the best afternoons in Ebmatingen near Greifensee that anyone can dream of. Y.F. would in particular like to thank Suju, Zhongyi and Katharina for great understanding, attention and steady family support during the long march in the last years. Finally, R.K. would like to thank Kasia, Basia and Ewa “za cierpliwość”.

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Long-Memory Processes
Probabilistic Properties and Statistical Methods
Beran, J.; Feng, Y.; Ghosh, S.; Kulik, R.
2013, XVII, 884 p. 89 illus., 60 illus. in color., Hardcover
ISBN: 978-3-642-35511-0