Preface

Linear processes have been one of the most fundamental tools in modeling serially dependent data. These models and methods heavily depend on Gaussian processes and their properties and therefore second-order moments have played the central role in this toolbox. Linear Gaussian models do not allow for large fluctuations and the stationary distribution when exists has fairly fast decaying tails, thus are not particularly adequate for modeling high variability. We are more and more aware that data coming from many scientific fields as diverse as telecommunications, hydrology or economics show heavy-tailed phenomena which are not compatible with Gaussian assumption. Therefore, such serially dependent data need richer parametrization based on nonlinear relations; consequently there is need to specify and model adequately observations coming from the tails. For such models, inferential methods based on second-order properties are no longer adequate and likelihood-based methods frequently cannot be used, since analytical expressions of likelihood often are not available. Least squares method, which is equivalent to likelihood-based inference for Gaussian processes, looses its nice properties as models deviate from Gaussian structure. Quasi-likelihood methods such as estimating functions and composite likelihood methods seem to work for some cases, whereas recent advances in sequential Markov Chain Monte Carlo (MCMC) methods and particle filters, as well as likelihood free methods such as approximate Bayesian computation (ABC), are quite promising alternatives in dealing with inference for nonlinear models. The objective of this book is to give an overall view of all these problems, including the consequences of nonlinearity on tails, some nonlinear models and adequate inferential methods.

There are many excellent books on nonlinear time series, responding adequately to these issues. Our approach is to introduce diverse topics that appear in different sources under one title which can serve as a reference source, without entering into details. We believe that the book may be particularly useful to graduate students and other scientists who want to have a starting source for further detailed study of the subject.

Chapter 1 gives many examples of nonlinear time series and different sources of nonlinearity. Chapter 2 introduces the basic notions of nonlinearity, and a collection of nonlinear models. There are many ways a process can be nonlinear, and correspondingly there are many different classes of models to cover such diverse sources. We do not claim that the models we introduce are exhaustive, but we hope this selection covers most sources of nonlinearity. Chapter 3 is on the tail behavior of nonlinear processes. The objective of this chapter is to show how nonlinear relationships generate heavy tails and to quantify the effect of nonlinearity on tails. Much is known on the extremal properties of linear and nonlinear time series and the objective of this chapter is to give a quick reference to these results. Chapter 4 gives inferential methods available for nonlinear processes, including several tests for nonlinearity. We hope that this chapter will be particularly useful as an integrated introductory text on inferential techniques, including Bayesian and simulation-based methods. Finally, in Chap. 5 we give linear models based on thinning operators for integer-valued time series. Although these models are linear in structure, technically they are nonlinear models. Many would favor observation-driven or parameter-driven state space models for dealing with such data sets. However, recently there has been a lot of interest for linear models based on thinning operators and there is an accumulation of a rich and diverse information on this subject. To our knowledge, this chapter is the first attempt to put together in a coherent manner these advances spread out in many journals and other sources.

Several institutions provided support for this work. We would like to thank FCT (Fundação para a Ciência e a Tecnologia) of Portugal, which supported our work through the projects PEst-OE/MAT/UI0006/2011, PEst-C/MAT/UI4106/2011, PEst-OE/MAT/UI4106/2014, and PTDC/MAT/118335/2010. The third author was also partially supported by a FCT Sabbatical Grant (ref FRH/BSAB/1138/2011) from 01 April 2011 to 29 July 2011. We also thank CEAUL – Center of Statistics and its Applications of the University of Lisbon – and CIDMA – Center for Research & Development in Mathematics and Applications – for their role in this initiative. Finally, we would like to thank Profs. John McDermott and Maria Antónia Amaral Turkman and Dr. Sónia Gouveia for reading the manuscript carefully and suggesting many useful comments which improved the content.

Lisbon and Aveiro, Portugal
May 2014

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http://www.springer.com/978-3-319-07027-8

Non-Linear Time Series
Extreme Events and Integer Value Problems
Turkman, K.; Scotto, M.G.; de Zea Bermudez, P.
2014, XII, 245 p. 41 illus., Hardcover
ISBN: 978-3-319-07027-8