Preface

This book is intended to provide researchers with the latest advances in the immensely broad field of time series analysis and forecasting (more than 200,000 papers published in this field since 2002 according to Thomson Reuters' Web of Science, see Fig. 1). Within this context, not only will we consider that the phenomenon or process where the values of the series come from is such that the knowledge of past values of the series contains all available information to predict future values, but we will also address the more general case in which other variables outside the series, also called external or exogenous variables can affect the process model. It should also be noted that these exogenous variables can be discrete variables (day of the week), continuous variables (outside temperature), and even other time series.

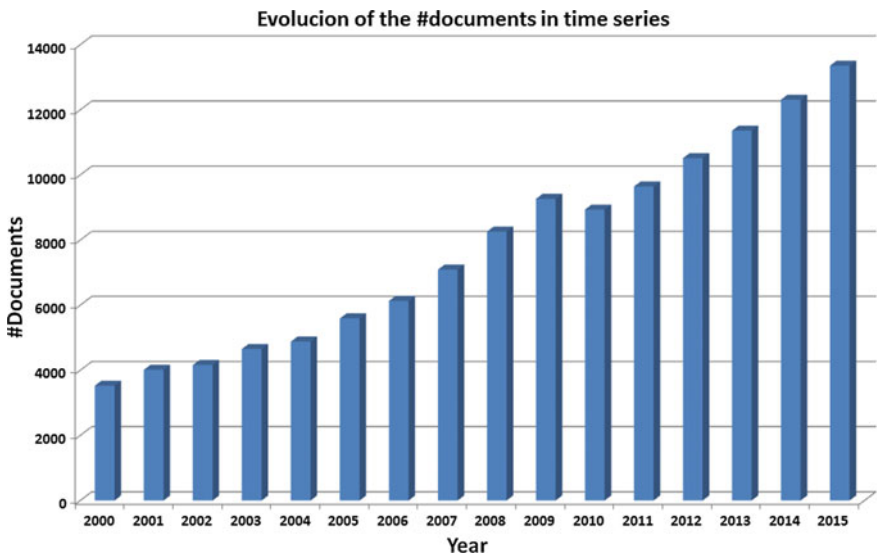


Fig. 1 Evolution of the number of documents in time series

The applications in this field are enormous, from weather forecasting or analysis of stock indices to modeling and prediction of any industrial, chemical, or natural process (see Fig. 2). Therefore, a scientific breakthrough in this field exceeds the proper limits of a certain area. This been said, the field of statistics can be considered the nexus of all of them and, for that reason, this book is published in the prestigious series "Contributions to Statistics" of the Springer publishing house.

The origin of this book stems from the International work-conference on Time Series, ITISE 2016, held in Granada (Spain) in June, 2016. Our aim with the organization of ITISE 2016 was to create a friendly discussion forum for scientists, engineers, educators, and students about the latest ideas and realizations in the foundations, theory, models, and applications for interdisciplinary and multidisciplinary research encompassing disciplines of statistics, mathematical models, econometrics, engineering, and computer science in the field of time series analysis and forecasting.

The list of topics in the successive Call for Papers has also evolved, resulting in the following list for the last edition:

1. **Time Series Analysis and Forecasting.**
   - Nonparametric and functional methods.
   - Vector processes.
   - Probabilistic approach to modeling macroeconomic uncertainties.
   - Uncertainties in forecasting processes.
   - Nonstationarity.
   - Forecasting with many models. Model integration.
   - Forecasting theory and adjustment.
   - Ensemble forecasting.
   - Forecasting performance evaluation.
   - Interval forecasting.
   - Econometric models.
   - Econometric forecasting.
   - Data preprocessing methods: data decomposition, seasonal adjustment, singular spectrum analysis, and detrending methods.
2. **Advanced Methods and Online Learning in Time Series.**
   - Adaptivity for stochastic models.
   - Online machine learning for forecasting.
   - Aggregation of predictors.
   - Hierarchical forecasting.
   - Forecasting with computational intelligence.
   - Time series analysis with computational intelligence.
   - Integration of system dynamics and forecasting models.
3. **High Dimension and Complex/Big Data**
   - Local versus global forecast.
   - Techniques for dimension reduction.

- Multi-scaling.
- Forecasting from Complex/Big data.

4. **Forecasting in Real Problems**

- Health forecasting.
- Telecommunication forecasting.
- Modeling and forecasting in power markets.
- Energy forecasting.
- Financial forecasting and risk analysis.
- Forecasting electricity load and prices.
- Forecasting and planning systems.
- Real-time macroeconomic monitoring and forecasting.
- Applications in other disciplines.

At the end of the submission process of ITISE 2016, and after a careful peer review and evaluation process (each submission was reviewed by at least 2, and on the average 2.7, program committee members or additional reviewers), 124 contributions were accepted for oral, poster, or virtual presentation, according to the recommendations of reviewers and the authors' preferences.

High-quality candidate papers (28 contributions, i.e., 22% of the contributions) were invited to submit an extended version of their conference paper to be considered for this special publication in the book series of Springer: Contributions to Statistics. For the selection procedure, the information/evaluation of the chairman

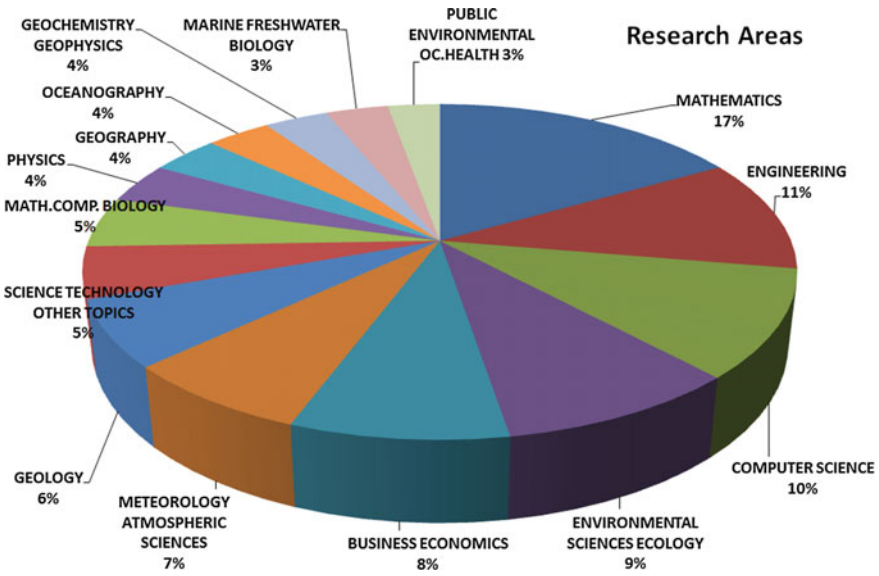


Fig. 2 Main research areas in time series

of every session, in conjunction with the review comments and the summary of reviews, were taken into account.

So, now we are pleased to have reached the end of the whole process and present the readers with these final contributions that we hope, will provide a clear overview of the thematic areas covered by the ITISE 2016 conference, ranging from theoretical aspects to real-world applications of Time Series Analysis and Forecasting.

It is important to note that for the sake of consistency and readability of the book, the presented papers have been classified into the following chapters:

- **Chapter 1: Analysis of irregularly sampled time series: techniques, algorithms, and case studies**. This chapter deals with selected contributions in the field of Analysis of irregularly sampled time series (topics proposed by Prof. Eulogio Pardo-Igúzquiza and Prof. Francisco Javier Rodríguez-Tovar), being the main objective the presentation of methodologies and cases studies dealing with the analysis of scales of variability of times series and joint variability between time series. As discussed by the organizers, "Unevenly spaced time series are very common in many scientific disciplines and industry applications. Missing data, random sampling, gapped data, and incomplete sequences, among other causes, give origin to irregular time series. The common approach to deal with these sequences has been interpolation in order to have an evenly sampled sequence and then to apply any of the many methods that have been developed for regularly sampled time series. However when the spacing between observations is highly irregular, interpolation introduces unwanted biases. Thus, it is desirable to have direct methods that can deal with irregularly sampled time series. This session welcomes contributions on this problematic: quantification of sampling irregularity in time series, advanced interpolation techniques and new techniques of analysis that can be applied directly to uneven time series. The main objective of this session is the presentation of methodologies and cases studies dealing with the analysis of time series with irregular sampling. The contributions can be on any area of time series analysis. Among others, areas of interest are: event analysis, trend and seasonality estimation of uneven time series, smoothing, correlation, cross-correlation and spectral analysis of irregular time series; non-parametric and parametric methods, non-linear analysis; bootstrap, neural networks and other soft-computing techniques for irregular time series; expectation-maximization and maximum entropy algorithms and any other technique that deals with uneven time series analysis. New theoretical developments, new algorithms implementing known methodologies, new strategies for dealing with uneven time series and case studies of time series analysis are appropriate for this special session." A total of four contributions were selected in this chapter.

- **Chapter 2: Multi-scale analysis of univariate and multivariate time series**. This chapter deals with selected contributions of an special session organized by Prof. Eulogio Pardo-Igúzquiza and Prof. Francisco Javier Rodríguez-Tovar

during ITISE 2016, being the main objective the presentation of methodologies and cases studies dealing with the analysis of scales of variability of times series and joint variability between time series. As discussed by the organizers: "every physical, physiological and financial time series has a characteristic behavior with respect to the scale at which it is observed. That is so because the time series is the output of a physical, biological or market system with a given dynamics resulting in one of two extremes, scale-invariant properties on one hand and scale-dependent properties on the other. In any case, each time series has variabilities at different temporal scales. Also the joint variability between each pair of variables may also be a function of scale. There are different approaches for doing such scale analysis, from classical spectral analysis to wavelets and from fractals to non-linear methods. The choice of a given approach may be a function of the question that one wants to answer or may be a decision taken by the researcher according to his/her familiarity with the different techniques." A total of four contributions were selected in this chapter.

- **Chapter 3: Lineal and Nonlinear time series models (ARCH, GARCH, TARCH, EGARCH, FIGARCH, CGARCH, etc.)**. In this chapter, classical methods such as ARIMA or ARMA methods, in conjunction with nonlinear model (such as ARCH, GARCH, etc) are analyzed. There are, for example, contributions which take into account that in time series analysis, noise is a relevant element which determines the accuracy of the forecasting and prediction, and in order to face with this problem, present an automatic, auto-adaptive, partially self-adjusting data-driven procedure, created to improve the forecast performances of a linear prediction model of the type ARIMA by eliminating noisy components within the high-frequency spectral portion of the series analyzed. In this chapter, comparison of different model Autoregressive Moving Average models and different Generalised Autoregressive Moving Average models is also discussed to forecast financial time series. Furthermore, examples of using linearl and nonlinear model for specific problem (for example, outlier detection) is presented.

- **Chapter 4: Advanced time series forecasting methods**. This chapter analyzed specific aspect of time series analysis and its hybridization with other paradigms (such as, for example, computer science and artificial intelligence. A total of five contribution were selected, where the reader can learn, for example, about:

  - how recurrent and feedforward models can be used for turbidity forecasting, predicting peaks of turbidity with 12 h lag time, presenting of a new architecture which take into account explicitly the role of evapotranspiration in this problem,
  - how to analyze and predict the productivity of the public sectors in the US across the states, using several methodologies, with combine exploratory (for understanding clusters of similar dynamics in an precise way, Self-Organizing Maps, SOM, clustering methods were employed (both raw time series and

unobservable components, such as trend and slope), and empirical techniques (e.g., panel model) via the Cobb–Douglas production function.
  - how to categorize/analyze multivariate time series (MTS) data. For the classification or clustering, a similarity measure to assess the similarity between two multivariate time series data is presented. There exist several similarity measures presented in the bibliography (dynamic time warping (DTW) and its variants, Cross Translational Error (CTE) based on multidimensional delay vector (MDV) representation of time series, Dynamic Translational Error (DTE), etc). Improved version of nowadays available similarity measures have been done using available benchmark data sets with simulation experiments.
  - how to model nonlinear relationships in complex time-dependent data, using the Dantzig-Selector convex optimization problem to determine the number and candidate locations of the Radial Basis Function Neural Networks, and analyze the performance of the methodology using the well-known Mackey-Glass chaotic time series (exploring time-delay embedding models in both three and four dimensions).

- **Chapter 5: Applications in time series analysis and forecasting**.
  Finally, we wanted to finish this book showing that it is really very important the application of the new methodologies development to real problems. No theory can be considered useful until it is put into practice and it is scientifically demonstrated the success of its predictions. That is what this chapter is about. It is shown how multiple and rather different mathematical, statistical, and computer science models can be used for so many analyses and forecasts of time series in fields such as wind speed and weather modeling, determining the pollen season (start and end), analysis of eye-tracking data for reading ability assessment, and forecasting models to predict the data of Malaysia KLCI price index, in which statistical models and artificial neural networks as machine learning techniques are simultaneously analyzed. The selection here was very strict, only four contributions, but we are confident to give a clear enough vision of what we have just said.

Last but not least, we would like to point out that this edition of ITISE was organized by the University of Granada together with the Spanish Chapter of the IEEE Computational Intelligence Society and the Spanish Network on Time Series (RESeT). The Guest Editors would also like to express their gratitude to all the people who supported them in the compilation of this book, and especially to the contributing authors for their submissions, the chairmen of the different sessions and to the anonymous reviewers for their comments and useful suggestions in order to improve the quality of the papers.

We wish to thank our main sponsors as well: the Department of Computer Architecture and Computer Technology, the Faculty of Science of the University of Granada, the Research Centre for Information and Communications Technologies (CITIC-UGR), and the Ministry of Science and Innovation for their support and

grants. Finally, we wish also to thank Prof. Alfred Hofmann, Vice President Publishing—Computer Science, Springer-Verlag and Dr. Veronika Rosteck, Associate Editor, Springer for their interest in editing a book series of Springer based on the best papers of ITISE 2016.

We hope the readers can enjoy these papers the same way as we did.

Granada, Spain
November 2016

Ignacio Rojas
Héctor Pomares
Olga Valenzuela



http://www.springer.com/978-3-319-55788-5

Advances in Time Series Analysis and Forecasting
Selected Contributions from ITISE 2016
Rojas, I.; Pomares, H.; Valenzuela, O. (Eds.)
2017, XV, 414 p. 112 illus., Hardcover
ISBN: 978-3-319-55788-5