Times Series: Modelling, Computation, and Inference, Raquel Prado and Mike West, CRC Press, Taylor and Francis Group, Chapman & Hall, Boca Raton, ISBN 978-1420093360 (hardcover, $89.95), xx+352 pages, by Christian P. Robert, Université Paris-Dauphine, Institut Universitaire de France, and CREST, Paris.

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Readership: Statistics graduate students with background in Bayesian statistics and stochastic processes, and researchers using time series modelling.

As a preliminary to this review, I must acknowledge a recurrent difficulty with most time-series textbooks. My mathematical upbringing makes me feel that, apart from Brockwell and Davis (2009), they provide too few mathematical bases for properly understanding notions that are foreign to iid settings, like stationarity, causality, spectrum. Hence, my regret that the otherwise comprehensive Prado and West's *Time Series* follows the same assumption of a prior familiarity with stochastic processes, Fourier transforms and spectral analysis, and ends up as a result hastily presenting those notions.

Time Series aims at "present[ing], summariz[ing] and overview[ing] core models and methods", plus "recent research developments". While the book stresses the Bayesian aspects of inference in time-series models more than its competitors, its first chapters are mostly standard. In the time domain (Chapter 2), Prado and West cover Bayesian estimation for AR, MA and ARMA models. The pace is fast, with a high "info-dump" rate, so most graduate students will likely need to consult some of the numerous references provided by the book to really master all concepts and techniques. For instance, reversible jump MCMC is covered in two paragraphs only and the reason why it is needed may escape the neophyte. At this stage, I would have welcomed a discussion about the oppositions between the conditional and unconditional representations of the models and between complex and real roots. Given the informal approach adopted about spectral theory, I

also think some parts on the frequency domain could have been omitted, apart as an entry to the literature.

The next group of chapters covers topics that are more central to the authors' interests, as expressed, e.g., in the earlier West and Harrison (1997), namely dynamic linear models (Chapter 4), state-space time-varying models (Chapter 5), and sequential Monte Carlo methods (Chapter 6). Dynamic linear models are highly polyvalent and adaptable models, hence capable of handling a large variety of stationary and non-stationary time series: Chapter 4 shows how many of the earlier introduced models fit within this framework. The authors mostly adopt the same perspective on the required MCMC methodology as in Petris et al. (2009), who provide the dlm R package. (A radically different but efficient approach to the non-sequential problem would be to use INLA, Ruiz-Cárdenas et al., 2010.) Chapter 5 gives a detailed processing of time-varying AR models by describing how the dynamic structure on the AR coefficients can be constructed, including some extensions posterior to West and Harrison (1997). Chapter 6 covers with enough details the more challenging problem of on-line or sequential processing of state-space models, discussing several SMC auxiliary particle algorithms (mostly the particle learning technique of Carvalho et al., 2010). Chapter 7 is about another instance of dynamic models, namely mixtures and hidden Markov models like stochastic volatility models, centred on a study of electroencephalograms published in Prado (2010).

The third and final part logically is about the extension of the above to multivariate time series, like VAR. Chapter 8 is an introduction to this extension, with new graphical representations for the estimated dynamic factor weights. Chapter 9 deals with vector AR and ARMA models, resorting to a corresponding state-space representation for drawing inference. Chapter 10 concludes by pointing out many recent references on multivariate dynamic linear models. (It also contains 15 pages of graphs with volatility estimates on European currencies, whose repetition somehow eludes me.)

In conclusion, *Time Series* constitutes a very modern entry to the field of time-series modelling, with a rich (17 pages) reference list of the current literature, including 85 references from 2008 and later. Well-written, each chapter is completed with a few exercises that can be used by an instructor or a self-taught student. This textbook can undoubtedly double as a reference manual for anyone entering the field or looking for an update. Teaching in a place where students study stochastic calculus prior to time-series courses, I am not in a position to judge the adequacy of the book as a graduate textbook, although I am certain there is more than enough material within *Time Series* to fill an intense one-semester course.

References

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