Discussiones Mathematicae
Probability and Statistics 30 (2010) 87–101
doi:10.7151/dmps.1122

EXPONENTIAL SMOOTHING AND RESAMPLING TECHNIQUES IN TIME SERIES PREDICTION

Maria Manuela Neves

CEAUL and Mathematics Department, Instituto Superior de Agronomia Technical University of Lisbon
Tapada da Ajuda, 1349–017, Lisboa, Portugal

e-mail: manela@isa.utl.pt

AND

Clara Cordeiro

Mathematics Department, Faculty of Science and Technology
University of Algarve, Faro, Portugal

e-mail: ccordei@ualg.pt

Abstract

Time series analysis deals with records that are collected over time. The objectives of time series analysis depend on the applications, but one of the main goals is to predict future values of the series. These values depend, usually in a stochastic manner, on the observations available at present. Such dependence has to be considered when predicting the future from its past, taking into account trend, seasonality and other features of the data. Some of the most successful forecasting methods are based on the concept of exponential smoothing. There are a variety of methods that fall into the exponential smoothing family, each having the property that forecasts are weighted combinations of past observations. But time series analysis needs proper statistical modeling. The model that better describes the behavior of the series in study can be crucial in obtaining "good" forecasts.

Departures from the true underlying distribution can adversely affect those forecasts. Resampling techniques have been considered in many situations to overcome that difficulty. For time series, several authors have proposed bootstrap methodologies. Here we will present an automatic procedure built in R language that first selects the best exponential smoothing model (among a set of possibilities) for fitting the data, followed by a bootstrap approach for obtaining forecasts. A real data set has been used to illustrate the performance of the proposed procedure.

Keywords: time series; bootstrap; exponential smoothing; forecasting; accuracy measures.

2000 Mathematics Subject Classification: 62F40, 60G25, 37M10.

References

[1] A.M. Alonso, D. Peña and J. Romo, *Forecasting time series with sieve bootstrap*, Journal of Statistical Planning and Inference **100** (2002), 1–11. doi:10.1016/S0378-3758(01)00092-1

[2] R.G. Brown, *Statistical Forecasting for inventory control*, New York, McGraw-Hill 1959.

[3] P. Bühlmann, *Sieve bootstrap for time series*, Bernoulli **3** (1997), 123–148. doi:10.2307/3318584

[4] C. Chatfield, *The Analysis of Time Series. An Introduction,* 6^{th} ed. Chapman & Hall 2004.

[5] C. Cordeiro and M.M. Neves, *The Bootstrap methodology in time series forecasting*, In "Proceedings of CompStat2006" (J. Black and A. White, Eds.), Springer Verlag (2006), 1067–1073.

[6] C. Cordeiro and M.M. Neves, *The Bootstrap prediction intervals: a case-study*, In "Proceedings of the 22nd International Workshop on Statistical Modelling (IWSM2007)" (J. Castillo, A. Espinal and P. Puig, Eds.), Springer Verlag (2007), 191–194.

[7] C. Cordeiro and M.M. Neves, *Bootstrap and exponential smoothing working together in forecasting time series*, In "Proceedings in Computational Statistics (COMPSTAT 2008)" (Paula Brito, Editor), Physica-Verlag (2008), 891–899.

[8] C. Cordeiro and M.M. Neves, *Forecasting time series with Boot.EXPOS procedure*, *REVSTAT*, **7:2** (2009), 135–149.

[9] E.S. Gardner, *Exponential smoothing: the state of the art*, J. of Forecasting, **4** (1985), 1–38. doi:10.1002/for.3980040103

[10] E.S. Gardner and E. Mckenzie, *Forecasting trends in time series*, Management Science **31** (1985), 1237–1246. doi:10.1287/mnsc.31.10.1237

[11] C. Holt, *Forecasting seasonals and trends by exponentially weighted averages*, O.N.R. Memorandum 52/1957, Carnegie Institute of Technology 1957.

[12] R. Hyndman, A. Koehler, R. Snyder and S. Grose, *A state framework for automatic forecasting using exponential smoothing methods*, International Journal of Forecasting **18** (2002), 439–454. doi:10.1016/S0169-2070(01)00110-8

[13] R. Hyndman, A. Koehler, J. Ord and R. Snyder, *Forecasting with Exponential Smoothing: The State Space Approach*, Springer-Verlag Inc 2008. doi:10.1007/978-3-540-71918-2

[14] C.C. Pegels, *Exponential smoothing: some new variations*, Management Science **12** (1969), 311–315.

[15] R Development Core Team, R: A language and enviroment for statistical computing, R Foundation for statistical computing, Vienna, Austria 2008. http://CRAN.R-project.org.

[16] J.W. Taylor, *Exponential smoothing with a damped multiplicative trend*, International Journal of ForecastingManagement Science **19** (2003), 273–289.

[17] P.R. Winters, *Forecasting sales by exponentially weighted moving averages*, Management Science **6** (1960), 349–362. doi:10.1287/mnsc.6.3.324

Received 21 January 2010