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COMPUTATIONAL INTENSIVE METHODS FOR PREDICTION AND IMPUTATION IN TIME SERIES ANALYSIS

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To Professor M. Ivette Gomes, an Extremal Friendship.

Abstract

One of the main goals in times series analysis is to forecast future values. Many forecasting methods have been developed and the most successful are based on the concept of exponential smoothing, based on the principle of obtaining forecasts as weighted combinations of past observations. Classical procedures to obtain forecast intervals assume a known distribution for the error process, what is not true in many situations. A bootstrap methodology can be used to compute distribution free forecast intervals. First an adequately chosen model is fitted to the data series. Afterwards, and inspired on sieve bootstrap, an AR(p) is used to filter the series of the random component, under the stationarity hypothesis. The centered residuals are then resampled and the initial series is reconstructed. This methodology will be used to obtain forecasting intervals and for treating missing data, which often appear in a real time series. An automatic procedure was developed in R language and will be applied in simulation studies as well as in real examples.

Keywords: bootstrap, forecast intervals, missing data, time series analysis.
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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] A.M. Alonso, D. Peña and J. Romo, *On sieve bootstrap prediction intervals*, Statistics & Probability Letters **65** (2003) 13–20. doi:10.1016/S0167-7152(03)00214-1

[3] P. Bickel, P. Diggle, S. Fienberg and K. Krickeberg, Nonlinear Time Series (Springer Series in Statistics, New York, Springer, 2003).

[4] R.G. Brown, Nonlinear Time Series (Statistical Forecasting for inventory control, New York, McGraw-Hill, 1959).

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

[6] E. Carlstein, *The use of subseries values for estimating the variance of a general statistic from a stationary sequence*, Annals of Statistics **14** (1986) 1171–1179. doi:10.1214/aos/1176350057

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

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

[9] 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 (Ed(s)), (Springer Verlag, 2007) 191–194.

[10] 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 (Ed(s)), (Physica-Verlag, 2008) 891–899.

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

[12] S.A. DeLurgio, Forecasting Principles And Applications (McGraw-Hill International Editions, 1998).

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

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

[15] P. Hall, *Resampling a coverage pattern*, Stochastic Processes and their Applications **20** (1985) 231–246. doi:10.1016/0304-4149(85)90212-1

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

[17] R. Hyndman, forecast: Forecasting functions for time series (software available at http://www.robjhyndman.com/Rlibrary/forecast/, 2011).

[18] R. Hyndman and Y. Khandakar, *Automatic Time Series Forecasting: The forecast Package for Rh*, Journal of Statistical Software **27** (2008).

[19] 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

[20] 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

[21] H. Künsch, *The Jackknife and the Bootstrap for General Stationary Observations*, The Annals of Statistics **17** (1989) 1217–1241. doi:10.1214/aos/1176347265

[22] S.N. Lahiri, Resampling Methods for Dependente Data (Springer Verlag Inc, 2003). doi:10.1007/978-1-4757-3803-2

[23] S. Makridakis and M. Hibon, *The M3-Competition: results, conclusions and implications*, International Journal of Forecasting **16** (2000) 451–476. doi:10.1016/S0169-2070(00)00057-1

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

[25] D. Politis and J. Romano, *A circular block-resampling procedure for stationary data*, in: Exploring the limits of bootstrap, Lepage, R. e Billard, L. (Ed(s)), (Wiley, 1992) 263–270.

[26] R Develpment core team, R: A Language and Environment for Statistical Computing (R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, URL http://www.R-project.org/, 2011).

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

[28] A. Trapletti, datasets: The R Datasets Package by A. Trapletti (package version 0.10, URL http://CRAN.R-project.org/package=datasets, 2008).

[29] A. Trapletti and K. Hornik, tseries: Time Series Analysis and Computational Finance (R package version 0.10-18, 2009).

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

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