

ON THE ESTIMATION OF THE AUTOCORRELATION FUNCTION

MANUEL DUARTE ORTIGUEIRA

*UNINOVA, Campus da FCT da UNL,
Quinta da Torre, 2825-114 Monte da Caparica, Portugal*

e-mails: mdortigueira@uninova.pt ; mdo@fct.unl.pt

Phone +351 1 2948520, Fax +351 1 2957786

Abstract

The autocorrelation function has a very important role in several application areas involving stochastic processes. In fact, it assumes the theoretical base for Spectral analysis, ARMA (and generalizations) modeling, detection, etc. However and as it is well known, the results obtained with the more current estimates of the autocorrelation function (biased or not) are frequently bad, even when we have access to a large number of points. On the other hand, in some applications, we need to perform fast correlations. The usual estimators do not allow a fast computation, even with the FFT. These facts motivated the search for alternative ways of computing the autocorrelation function. 9 estimators will be presented and a comparison in face to the exact theoretical autocorrelation is done. As we will see, the best is the AR modified Burg estimate.

Keywords: time-series autocorrelation, regression.

2000 Mathematics Subject Classification: 37M10.

REFERENCES

- [1] G.E. Box, G.H. Jenkins and G.C. Reinsel, *Time Series Analysis: Forecasting and Control*, 3^a edition, Prentice-Hall 1994.

- [2] J.P. Burg, *Maximum Entropy Spectral Analysis*, Proceedings of the 3th Meeting of the Society of Exploration Geophysicists, 1967, in *Modern Spectrum Analysis*, Ed. Donald Childers, IEEE Press 1978.
- [3] J.P. Burg, *A New Analysis Technique for Time Series Data*, Nato Advanced Study Institute on Signal Processing with Emphasis on Underwaters Acoustics, Enschede, Holanda, 1968 in *Modern Spectrum Analysis*, Ed. Donald Childers, IEEE Press.
- [4] M.J.L. De Hoon, T.H.J.J. van der Hagen, H. Schoonewelle and H. van Dam, *Why Yule-Walker should not be used for Autoregressive Modelling*, *Annals of Nuclear Energy* **23** (1996), 1219–1228. doi:10.1016/0306-4549(95)00126-3
- [5] T.L. McWhorter and L.L. Scharf, *Multiwindow Estimators of Correlation*, *IEEE Transactions on Signal Processing* **46** (2) February 1998. doi:10.1109/78.655428
- [6] S.L. Marple, *A New Autoregressive Spectrum Analysis Algorithm*, *IEEE Trans. on ASSP* Vol. 28, Agosto 1980.
- [7] S.L. Marple, *Digital Spectral Analysis with Applications*, Prentice-Hall 1987.
- [8] B.J.F. Murteira, D.A. Müller e K.F. Turkman, *Análise de Sucessões Cronológicas*, McGraw-Hill 1993.
- [9] A.V. Oppenheim and R.W. Schafer, *Digital Signal Processing*, Prentice-Hall, Englewood Cliffs 1975.
- [10] M.D. Ortigueira and J.M. Tribolet, *Global versus local minimization in least-squares AR Spectral Estimation*, *Signal Processing* **7** (3) (1984), 267–281. doi:10.1016/0165-1684(84)90004-5
- [11] M.D. Ortigueira, *Introduction to Fractional Linear Systems. Part 2: Discrete-time Systems*, *IEE Proceedings Vision, Image and Signal Processing* **147** (1) (2000), 71–78. doi:10.1049/ip-vis:20000273
- [12] A. Papoulis and S.U. Pilai, *Probability, Random Variables, and Stochastic Processes*, McGraw-Hill Book Company 2002.
- [13] M.C. Sullivan, *Efficient Autocorrelation Estimation Using Relative Magnitudes*, *IEEE Transactions On Acoustics, Speech. And Signal Processing* **37** (3) (1989). doi:10.1109/29.21717
- [14] D.J. Thomson, *Using Local Eigen Expansion to Estimate Spectrum in Terms of Solution of Integral Equations*, *Proceedings of IEEE*, Setembro 1982.
- [15] D.J. Thomson, *Quadratic-inverse spectrum estimates: applications to paleoclimatology*, *Philos. Trans. R. Soc. Lond.* **332** (1627) (1990), p. 539. doi:10.1098/rsta.1990.0130

- [16] K.S. Riedel and A. Sidorenko, *Minimum bias multipletaper spectral estimation*, IEEE Trans. Signal Processing **43** (1995), 188–195.
doi:10.1109/78.365298

Received 14 May 2010