# Nonparametric time series analysis

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## Pisa, St. Anna School, October 2006

## Topics covered

- *Motivation and background; measures of complexity from chaos theory*: Takens' reconstruction theorem, correlation integrals, fractal dimensions, correlation entropy, estimation of dynamic invariants, local linear prediction

- *Nonparametric tests based on correlation integrals*: Divergences between reconstruction measures, U-statistics estimators, tests for symmetry of multivariate distributions, attractor comparison, testing for reversibility, tests for serial independence and linearity

- *Statistical aspects of nonparametric tests*: asymptotic results for U-statistics in time series context, bootstrap and Monte Carlo tests, consistency, bandwidth selection problem, diagnostic model checking, nuisance parameters, tests based on empirical copulas

- *Granger causality tests*: conditional independence, linear versus nonlinear Granger causality, nonparametric Granger causality tests, testing for Granger causality using correlation integrals, consistency, local measures of conditional dependence

## Relevant reading

**Background**

- F. Takens (1981) Detecting strange attractors in turbulence, In: *Dynamical Systems and Turbulence, Warwick 1980, Lecture Notes in Mathematics, 898* (eds. D. Rand and L.-S. Young), pp. 366–381, Springer, Berlin

- P. Grassberger and I. Procaccia (1983), Measuring the strangeness of strange attractors, *Physica D* 9, 189–208.

- M. Casdagli (1989) Nonlinear prediction of chaotic time series, *Physica* D 35, 335–356.

- **P. Grassberger, T. Schreiber and C. Schaffrath (1991) Nonlinear time sequence analysis, *International Journal of Bifurcation and Chaos* 1, 521–547**

- M. Casdagli (1992) Chaos and deterministic versus stochastic nonlinear modeling, *Journal of the Royal Statistical Society, Series B* 54 (2),303–328

- **C. Diks (1996) Estimating invariants of noisy attractors, *Physical Review E* 53, R4263–R4266.**

**Tests for serial independence, linearity, etc.**

- W. A. Brock, W. D. Dechert, J. A. Scheinkman and B. LeBaron (1996) A test for independence based on the correlation dimension, *Econometrics Review* 15 (3) 197–235

- **C. Diks, J. C. van Houwelingen, F. Takens and J. DeGoede (1995) Reversibility as a criterion for discriminating time series, *Physics Letters A* 201, 221–228.**

- M. J. van der Heijden, C. Diks, J. P. M. Pijn and D. N. Velis (1996) Time reversibility of intracranial human EEG recordings in mesial temporal lobe epilepsy, *Physics Letters A* 216, 283–288.

- **C. Diks, W. R. van Zwet, F. Takens and J. DeGoede (1996) Detecting differences between delay vector distributions, *Physical Review E* 53, 2169–2176.**

- M. J. van der Heijden, C. Diks, B. P. T. Hoekstra and J. DeGoede (1998) Testing the order of discrete Markov Chains using surrogate data, *Physica* D 117, 299–313.

- C. Diks and H. Tong (1999) A test for symmetries of multivariate probability distributions, *Biometrika* 86, 605–614.

- D. Yu, M. Small, R.G. Harrison and C.G.H. Diks (2000) An efficient implementation of the Gaussian kernel algorithm in estimating invariants and noise levels from noisy time series data, *Physical Review E*, 61 (4), 3750–3756.

- **C. Diks and S. Manzan (2002) Tests for serial independence and linearity based on correlation integrals, *Studies in Nonlinear Dynamics and Econometrics*, 6 (2), art. no. 2, 1–22**

- C. Diks (2003) *Detecting serial dependence in tail events: a test dual to the BDS test*, Economics Letters 79 (3), 319–324

- **C. Diks and V. Panchenko (2006) *Nonparametric Tests for Serial Independence Based on Quadratic Forms*, Statistica Sinica, Forthcoming.**

**Granger causality**

- W. Brock and E. Baek (1992) A general test for nonlinear Granger causality: bivariate model, Working Paper, Iowa State university and University of Wisconsin, Madison

- **C. Hiemstra and J. D. Jones (1994) Testing for Linear and Nonlinear Granger Causality in the stock price-volume relation, *Journal of Finance* 49 (5) 1639–1664**

- C. Diks and V. Panchenko (2005) A note on the Hiemstra-Jones test for Granger non-causality, *Studies in Nonlinear Dynamics and Econometrics*, 9 (2), Art. No. 4, 1–7

- **C. Diks and V. Panchenko (2006) A new statistic and practical guidelines for nonparametric Granger causality testing, *Journal of Economic Dynamics and Control*, 30 (9–10), 1647–1669.**