Extracting extreme aspects from series of random dynamical systems

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Abstract

Extracting chaotical ([2]) and stochastic parts of information from time series needs very specific techniques. Motivated by two applications, image processing for cancer discrimination (see [9]) and methane emissions modelling (see e.g. [3, 4, 6]) we will explain the necessary techniques for statistical learning on chaotical and stochastic parts from data. In particular, Tsallis Entropy will be introduced and its role in information theory for dynamical system explained. Iterated function systems will be used as an example for chaos re-simulation (see e.g.[8]). In particular, a construction of stochastic fractals will be discussed. All can be well integrated to both natural and technical sciences, which gave us an optimal instrument for the decomposition of data to stochastic, deterministic and chaotic part (see [10]).

In particular, several important issues regarding cell cycle dynamics will be given. The correlation dimension algorithm used by [7] is not a good choice, since albeit the method is algoritmizable, it is not possible to use it for any comparisons (and in particular for calibration with real data), since it is not satisfying so called monotonicity condition.

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References

[1] T.M. Addiscott: *Entropy, non-linearity and hierarchy in ecosystems*, Geoderma 160, 57-63, 2010.

[2] M.P. Holland, R. Vitolo, P. Rabassa, A.E. Sterk, H. Broer: *Extreme value laws in dynamical systems under physical observables*, arXiv:1107.5673v1 28 July 2011.

[3] P. Jordanova, J. Dušek, M. Stehlík: *Modeling methane emission by the infinite moving average process*. Chemometrics and Intelligent Laboratory Systems, Vol. 64, No. 122, 40-49, 2013.

[4] P. Jordanova, J. Dušek, M. Stehlík: *Microergodicity effects on ebullition of methane modelled by Mixed Poisson process with Pareto mixing variable.* Chemometrics and Intelligent Laboratory Systems, 128 124-134, 2013.

[5] Ya. Pesin, On Rigorous Mathematical Definition of Correlation Dimension and Generalized Spectrum For Dimensions, J. Stat. Phys., v. 71, N3-4 (1993) 529-547

[6] R. Sabolová, V. Sečkárová, J. Dušek, M. Stehlík: *Entropy based statistical inference for methane emissions released from wetland*, submitted for Chemometrics and Intelligent Laboratory Systems, 2014.

[7] O. Sandler, S.P. Mizrahi, N. Weiss, O. Agam, I. Simon and N. Q. Balaban, Lineage correlations of single cell division time as a probe of cell-cycle dynamics, Nature 468, VOL 519, 2 0 1 5

[8] Ö. Stenflo: *Iterated function systems with a given continuous stationary distribution*, Fractals, 20, Nos. 3 & 4, 197202, 2012.

[9] M. Stehlík, S. Giebel, J. Prostakova, J.P. Schenk: *Statistical inference on fractals for cancer risk assessment.* Pakistan Journal of Statistic, Vol. 30(4), 439-454, 2014.

[10] M. Stehlík, J.Dušek, J.Kiselák, Missing chaos in global climate change data interpreting? Ecological Complexity, 25 (2016) 5359