

GENERALIZED STATISTICAL COMPLEXITY MEASURE:

A NEW TOOL FOR DYNAMICAL SYSTEMS.

Oswaldo A. Rosso

(1) *LaCCAN/CPMAT - Instituto de Computação.
Universidade Federal de Alagoas (UFAL), Brazil*

(2) *Laboratorio de Sistemas Complejos,
Facultad de Ingeniería. Universidad de Buenos Aires (UBA), Argentina*

E-mail: oarosso@gmail.com

López-Ruiz, Mancini and Calbet have proposed a statistical complexity measure, based on the notion of “disequilibrium”, as a quantifier of the degree of physical structure in a time series. Given a probability distribution P and its associate information measure $I[P]$, an amount of “disorder” associated to the state of a system, the LMC-statistical complexity, is the product of a normalized entropy H (normalized Shannon-entropy) times the disequilibrium Q , given by the Euclidean “distance” from P to the uniform distribution P_e . The statistical complexity vanishes both for a totally random process and for a purely periodic one. Martín, Plastino and Rosso improved on this measure by suitably modifying the distance-component (in the concomitant probability space). The obtained MPR-statistical complexity is (i) able to grasp essential details of the dynamics, (ii) an intensive quantity, and (iii) capable of discerning among different degrees of periodicity and chaos. The MPR-statistical complexity can be viewed as a functional that characterizes the probability distribution P associated to the time series generated by the dynamical system under study. It quantifies not only randomness but also the presence of correlational structures. In this seminar, selection of the information measure I and generalized disorder, as well as, election of distance D and generalized disequilibrium are reviewed. Evaluation of the probability distribution P associated to a dynamical system or time series under study is a physical problem. Additional improvements can be expected if the underlying probability distribution is “extracted” by more appropriate consideration regarding causal effects in the system’s dynamics. Several well-known model-generated time series, usually regarded as being of either stochastic or chaotic nature, are analyzed. The main achievement of this approach is the possibility of clearly distinguishing between them in the $H \times$ MPR-Complexity representation space, something that is rather difficult otherwise. In addition, recent applications to time series from biological (epileptic EEG records, deformation of red blood cells, cancer progression, etc.) and physics systems (stochastic resonance, econophysics, literature, ENSO/El Niño, etc.) will be reviewed.