Abstracts of Talks in IX WWlet 2019

Wavelet-based Clustering and Classification

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In this work we consider several wavelet-based procedures for clustering and classification purposes. In some situations, the time domain approach may not lead to clear classification or discrimination. When we move to the wavelet domain, the multiresolution analysis leads to look at data in several levels of resolution (or scales) and then the separation may become better. Among the wavelet-based procedures, we mention:

(a) Multifractal Spectra (MFS) and associated descriptors.

(b) DWT-CEM procedure: discrete wavelet transform combined with classification expectation maximization algorithm.

(c) DWT-Schur measures: discrete wavelet transform followed by the use of some Schur monotone measure.

(d) Wavelet-based Bayesian discriminant function.

(Joint work with C. Chiann, J.R. Sato and B. Vidakovic)

Wavelet Statistical Analysis of Multitemporal SAR and satellite images

Aluísio Pinheiro – Unicamp

We discuss here the use of wavelets for the analysis of multitemporal SAR and satellite images. Nonlinear wavelet representation of images as well as non-linear wavelet density analyses are employed for the smoothing of time series of satellite and SAR images. A procedure is proposed for the detection of temporal changes. Wavelets are shown to be statistically efficient for this task. Moreover, due to the high resolution and large number of acquisition times, the well-known wavelet fast algorithms and compact representation are paramount. A long time series of SAR images from northern Brazil are used for illustration.

Partial Directed Wavelet Covariance for Locally Stationary Processes.

Kim Samejima

We generalize the directed wavelet covariance (DWC) for multivariate locally stationary processes by decomposing the total covariance structure of these processes in the wavelet domain. DWC is an alternative to evaluate directed relation between two univariate locally stationary processes. The partial directed wavelet covariance (pDWC), on the other hand, excludes the influence of exogenous variables before measuring the relation between

the components of a multivariate locally stationary process. We also present simulation results comparing pDWC and partial directed coherence (PDC) and an application of pDWC in EEG data.

Multi-scale identification of dynamics in chaotic electrochemical oscillators

Luciano A Magrini - UFJF

Dynamical systems related to climate models, relaxation oscillators (as Van der Pol, cardiac cells or neural activity, for example) exhibits different timescales in your manifestations. The comprehension of full dynamics in these dynamical systems whose behavior exhibits two or more different time scales generally is complicated because each time scale presents one specific behavior in the time domain and can manifest together or in specifics time intervals. In this work using wavelet techniques, we calculated approximations for each dynamics (namely slow and fast dynamics, respectively) considering only the inverse wavelet transform applied in specifics frequency bands presents in one-dimensional time-series related to experimental data obtained from oscillators coupled in a network where slow dynamics is chaotic and fast dynamics is characterized in time-domain by irregular bursting's. The applied methodology show that it is possible calculated good approximations for each different dynamics and that particularly to slow dynamics the small frequency contributions cannot be discarded without to introduce deformations in your manifestation in time-domain. The principal advantage of our approach is that only is necessary to know one-dimensional time-

series about the full multiple time-scale dynamical system considered because all process is performed in the frequency domain by wavelet analysis.

Geomagnetic disturbances in a local regularity point of view

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The Sun affects the Earth's environment by three principal agents: electromagnetic radiation, high energy particles and magnetized plasma structures. The planetary atmosphere is heated and ionized, constituting processes that create plasmas surrounding the planet. The geomagnetic field creates a complex system composed by plasmas in the geospace. Currently there are several measurements obtained in space by satellites and probes, and on the ground by geomagnetic observatories. Those kinds of measurements compose nowadays long time series and most of them are updated in quasi real-time. A challenge of the analysis is to deal with processes occurring in space-time. These phenomena are associate to non-linear plasma physics. This work presents the results of the application of a wavelet methodology to identify local disturbances in these geomagnetic time series based on the amplitude and scale of the wavelet coefficients to characterize geophysical signatures. The importance is a novel way to identify, quantify and investigate the Sun-Earth electrodynamics coupling processes, whose understanding is crucial to day by day on Earth considering the avaiable electric and electronic devices. In special for the South America region several particular geoeffects require these kind of evaluation.

Evaluation of genome similarities: a wavelet-domain approach

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The wavelet transform is a technique of seeing and represents a signal which is decomposed at different levels of resolution, where each level brings a detailing. Mathematically, it is represented by a function oscillating in time or space. As a feature, it has sliding windows that expand or compress to capture low and high frequency signals, respectively. One of the characteristics of wavelet analysis into genomic data is the extraction of features that are hidden. We applied the discrete non-decimated wavelet transform, NDWT, to the GC-content sequences of the Mycobacterium tuberculosis (MTB) genome strains. The GC-content is an important parameter of bacterial genomes used to scan the basic composition of the genome as well as to understand the evolution of the coded sequence. We propose a clustering method to similarities of genomes based on the energy, lasso and elastic net method. The energy (variance) obtained at each level provides a new set of information that can be used to search similarities between sequences. The elastic net simultaneous does automatic variable selection and continuous shrinkage, and it can select groups of correlated variables. The proposed methodology is applied to MTB sequences, being 4 Drug Resistant, 4 Drug Susceptible, 1 Multi Drug Resistant and 1 Extensively Drug Resistant, obtained from NCBI (2017).

Wavelet Neural Networks for prediction and classification

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In deep learning and machine learning, several models and classification methods have been proposed. A prominent method refers to Neural Networks (NN), which have the capacity to approximate any non-linear process, with little knowledge and without assumptions about the nature of the process. However, the usual activation functions (sigmoids) present a number of disadvantages.

These drawbacks are going to be discussed in this presentation as well as about an alternative based on the integration of wavelet and NN. In contrast to other transfer functions, the wavelet activation functions have several desirable properties. Furthermore, it is expected that the waveforms of the wavelet activation function capture better the seasonalities and periodicities of the stochastic processes, both in the mean and in the variance. Wavelets do not present problems with discrete data, as in many other methods, they do not require so much training time or so much memory, they have high capacity of compression and estimation with few neurons. The WN can be used in a variety of applications, such as time series prediction, signal classification and compression, signal processing, static, dynamic and nonlinear modeling. Some applications for prediction and classification will be showed.