Mathematics, Modeling and Data Science Workshop

Mulhouse, 14-15 December 2017

Speakers
Dragan Poljak (Split, Croatie), Pasha Zusmanovich (Ostrava, Tchéquie), Nikolaos Limnios (Sorbonne-Compiègne), Patrice Wira (UHA), Jonathan Weber, Germain Forestier (UHA), Sixin Zhang (ENS Paris), Loic Tessier (Strasbourg)

Organizers. Zakaria Belhachmi, Abdenacer Makhlouf, Patrice Wira.

Programme

Thursday December, 14th 2017 (Bâtiment de Mathématique, salle 4)

14:00 Loïc Teyssier (University of Strasbourg)
Effective computation of graphs associated to harmonic planar vector fields and applications to Dessins d'enfants

15:00 Dragan Poljak (Split, Croatia)
Computational models in Electromagnetics: Applications in antennas, ground penetrating radar, bioelectromagnetics, grounding Systems, transmission lines, lightning and plasma physics.

Coffee break

16:30 Germain Forestier (University of Haute Alsace)
Analysis and classification of temporal data

17:30 Table ronde/Discussion

Friday December, 14th 2017 (FST 18, Amphi Gaston Berger)

8:30 Nikolaos Limnios (University of Sorbonne-Compiègne)
Random evolution in discrete-time : asymptotic and applications

9:30 Pasha Zusmanovich (Ostrava, Czech)
On correlation matrices and versal deformations

Coffee break

11:00 Patrice Wira (University of Haute Alsace)
From Sensing the Real World to Smart Systems with Data Analysis and Machine Learning

12:00 Sixin Zhang (ENS Paris)
Texture Modeling with scattering Transforms

Lunch

Abstracts

Pasha Zusmanovich (Ostrava, Czech)

On correlation matrices and versal deformations

Abstract. We will show how the practice, adopted by many financial institutions, of evaluation of approximate correlation matrices between large amount of financial instruments, can be explained from the point of view of Arnold's theory of versal deformation of matrices. We will also speculate about possible application of the same theory to a problem of justification of CONCOR, i.e. to the convergence of iterative correlation matrices, a method frequently employed in statistical analysis in psychology, sociology, and other disciplines.

Germain Forestier (University of Haute Alsace)

Analysis and classification of temporal data

Abstract. In this talk I will present our most recent work on time-series and sequence analysis. In the first part, I will present a data reduction technique consisting in averaging sets of time-series and replacing each set by its average to speed-up and to improve nearest neighbor classification. As our method relies on Dynamic Time Warping (DTW), I will explain how to compute a consistent average time series under time warping. I will also present how this methodology can be used for data augmentation. In the second part, I will discuss our work on surgical data science, which supports surgery via the analysis and understanding of operating room activities. I will present our work on analyzing sequences of surgical activities and I will show how our methods make it possible to identify different surgical behaviors and support surgical skills assessment.

Sixin Zhang (ENS Paris)

Texture Modeling with scattering Transforms

Abstract. We study how to model the texture as a stationary and ergodic random process. The texture is assumed to be homogenous in two-dimensional space, i.e. stationary under translation, and is ergodic in sense that the statistics do not differ considerably from one single realisation to another. These statistical properties fit well the classical microcanonical modeling framework, resulting in a maximum entropy process satisfying a pre-defined set of statistics. The main challenge is to define this set of statistics so as to capture the non-Gaussianarity of the underlying random process, in particular when the texture has long-range dependency and complex geometry such as vorticity solutions two-dimensional Navier-Stokes equation. One common way to evaluate the model is to synthesis texture of similar visual quality and variability. We use the scattering transform to capture the geometric correlations in the space beyond second order statistics. The basic idea is to model progressively the Gaussian and non-Gaussian part of the random process through a cascade of convolutional and non-linear transforms. When the random process is a Gaussian process, we use the l2 moments of the 1st order scattering coefficients to approximate its covariance structure. We evaluate the Gaussian model by standard metrics in power spectrum estimation. The use of the Gabor wavelets in 1st order scattering also extracts the non-Gaussian statistics. The non-linear modulus operator is then applied to introduce the correlations between across scales and angles. We then build a second order model with PCA to capture these non-Gaussian correlations by the 2nd order scattering coefficients. We will present results on the synthesis texture of Turbulence and Brodatz texture dataset.