la RECHERCHE à l'Université

10es journées scientifiques

Réseaux et dynamiques : De la compréhension du cerveau aux problèmes de transport en turbulence

Mardi 26 et Mercredi 27 avril 2016
Plot FARON - salle FA.705

Campus de Toulon
Porte d'Italie

UNIVERSITÉ DE TOULON

26 Thuesday april 2016

8:30 Accueil des participants

9:00 Ouverture des 10es Journées Scientifiques de l'Université de Toulon, amphithéâtre FA.001

10:30 *Aurelien DECELLE*, Laboratoire de Recherche en Informatique (LRI), Université Paris-Sud

Mean-field theory for the inverse Ising problem

Abstract: Recently, inverse problems have been the focus of a lot of work, both from theoretical and practical aspect. From the practical point of view, many different fields are now doing inference tasks using the Ising model (machine learning, neuroscience, social science...). The need of a proper mean-field theory is then becoming necessary when dealing with large dataset and large system sizes for which the usual Boltzmann learning is too slow to be used in practice. In this presentation, I will review the recent results on the mean-field theory, and why it was not optimal until recently. Then, I will explain how MF theory should be apply on systems with multiple phases at low temperature.

11:00 *Simon VILLAIN-GUILLOT*, Laboratoire Ondes et Matière d'Aquitaine (LOMA), Bordeaux

Interrupted coarsening in generalized Cahn-Hilliard Model and localisation of surface active agents

Abstract: The Cahn-Hilliard equation describes the dynamics of phase separation in the conservative case (first order phase transition). This process is driven by the minimization of the free energy, especially of its interfacial part, during the Ostwald ripening, or coarsening [1]. In 1D however, the lower energy state that should end the dynamics is very slow to reach. This is even more the case when the Cahn-Hilliard dynamics is modified to take into account long range interaction terms [2]: the lower energy state is then only reached for particular initial states. A dynamical criterion proposed by Misbah and Politi [3] to predict the end of the coarsening process (and the final wave length of the pattern) shows results that differ from the simple minimization of the free energy. In order to understand this difference, we have investigated possible transition modes that may describe the dynamic of coarsening in those systems. We have also explored a model where the Cahn Hilliard dynamics is coupled with a diffusion equation for the surfactant that favors interfaces. This scenario enables to speed up the dynamics and favors pattern formation or micro-structuration. (Joint work with Mahdi Mcheik).

References:

[1] 1D Cahn-Hilliard dynamics : coarsening and interrupted coarsening pages 153-168 in « Discontinuity and Complexity in Nonlinear Physical Systems », Editors: J. Tenreiro Machado, Dumitru Baleanu, Albert Luo. Springer (2014)

[2] Dynamics versus energetics in phase separation P. Politi and A. Torcini J. Stat. Mech. P03016 (2015)

[3] When does coarsening occur in the dynamics of one-dimensional fronts? P. Politi and C. Misbah, Phys. Rev. Lett. 92, 090601 (2004).

11:30 *Cyril FURTLEHNER*, Laboratoire de Recherche en Informatique (LRI) & INRIA, Université Paris-Sud

Cycle-based Cluster Variational Method for Direct and Inverse Inference

Abstract: Inference problems in machine learning like for example traffic inference on large scale road networks can be possibly addressed with help of Markov random fields and belief propagation algorithms. There are two related problems here: the first one is to find off line the parameters of the MRF from empirical data (inverse problem); the second one (direct problem) is to make the inference algorithm as precise and fast as possible to be able to deal with real time and large scale applications.

In this work we address both the direct and inverse problem. We elaborate on the idea that loop corrections to belief propagation could be dealt with in a systematic way on pairwise Markov random fields, by using the elements of a minimal cycle basis to define region in a generalized belief propagation setting. The region graph is specified in such a way as to avoid dual loops as much as possible. We end up with a two-level algorithm, where a belief propagation algorithm is run alternatively at the level of each cycle and at the inter-region level. The inverse problem of finding the couplings of a Markov random field from empirical covariances can be addressed region wise. It turns out that this can be done efficiently in particular in the Ising context, where fixed point equations can be derived along with a one-parameter log likelihood function to minimize. Numerical experiments confirm the effectiveness of these considerations both for the direct and inverse MRF inference, in particular where large scale heterogeneous graphs can be dealt with.

12:30 Pause déjeuner

14:30 *Demian BATTAGLIA*, Institut de Neurosciences des Systèmes (INS), AMU

Are brain functional networks performing an anomalous diffusion?

Demian BATTAGLIA, Institut de Neurosciences des Systèmes (INS), AMU

Abstract: All brain functions, from perception or motor preparation up to attention and awareness, require the dynamically orchestrated exchange of information between a large number of areas. In cognitive neuroscience and neuroimaging, interactions between local regions are tracked in terms of the so called « functional connectivity » analysis, in which couplings between pairs of regions are estimated as some metric (e.g. correlation, Granger causality or information theoretical functionals) extracted from their respective time-series of activity. Such pairwise couplings are then compiled into functional networks, i.e. graphs describing brain-wide patterns of inter-areal coordination.

While most studies focus on time-averaged functional connectivity, it has recently been emphasised that functional networks are characteristically non-stationary and that their dynamics, may have an even stronger biomarking potential (in aging studies, to detect pathologies, etc.) than their static topological aspects. Nevertheless we lack a dynamical systems understanding of the possible origin of functional connectivity dynamics. Furthermore the use of proper statistical or time-series analysis tools to characterize such

time-varying networks is not yet widespread in neuroscience. We will first present here a simple computational model of large-scale brain dynamics able to reproduce at least some aspects of the experimentally observed non stationarity of functional connectivity in human resting state fMRI data, hinting at a possible link with noise-driven out-of-equilibrium exploration of a complex multi-attractor phase space. In a second part, we will have a closer look to data characterizing functional connectivity dynamics as a stochastic process in the space of possible functional graphs. The tentative conclusion will be that Functional brain networks evolve through some anomalous diffusion process, akin to a Levy-type walk.

15:00 *Alain BARRAT*, Centre de Physique Théorique (CPT), AMU

Networks of human contacts: from data to applications

Abstract: Face-to-face contacts between individuals play an important role in social interactions and can also determine the potential transmission routes of infectious diseases, in particular of respiratory pathogens. An accurate description of these patterns is therefore of interest for the fundamental knowledge and understanding of human behaviour and social networks as well as in epidemiology, in order to identify contagion pathways, to inform models of epidemic spread, and to design and evaluate control measures such as the targeting of speci_c groups of individuals with appropriate prevention strategies or interventions.
In this talk, I will present results obtained by the SocioPatterns collaboration (www.sociopatterns.org), which focuses on measuring and modeling human contacts, and on using the gathered knowledge in fields such as social science or epidemiology. I will briey describe the SocioPatterns sensing platform and some of the datasets collected in the last years. I will show how such datasets can be of use to investigate issues of interest in the epidemiology of infectious diseases, such as the relative efficiency of various mitigation measures such as the targeted closure of classes in schools or the closing of whole schools, in case of an epidemic spread. I will also discuss the issue of how incomplete data sets can bias the outcome of simulations and describe methods to compensate for such biases.

15:30 Pause café.

16:00 *Sarah DE NIGRIS*, Centre Namurois des Systèmes Complexes (naXys), Université de Namur

Understanding the XY model collective behaviours through graph signal analysis

Abstract: In various context, high-dimensional data reside on the vertices of networks, so that the network is the natural space for such systems. Therefore techniques, as Graph Signal Transform, levering the structure of the network, to grasp the main features of the dynamical process upon it are drawing increasing attention. Graph Signal Transform is, by design, well-suited to treat signals in very irregular domains and it allows applications that span from image compression to uncovering network communities [1]. In this work, we apply Graph Signal Transform to a classical model for magnetized materials, the XY spin model of which we consider the phenomenology on networks. Remarkably, there is recent evidence that a variety of collective responses can be ignited if a complex network connects

the spins [2-3]. In particular, we observe the same collective state on different networks through a fine tuning of the network topological parameters. We focus on the Graph Signal Transform to benchmark the time series produced by the model in the three macroscopic states at equilibrium [4]. Through this benchmarking phase, we retrieve the selected network modes for each macroscopic state on different topologies and this selection points to the sub-structures of the graph relevant for the dynamics.

[1] D. Shuman, S. K. Narang, P. Frossard et al., Signal Processing Magazine, IEEE 30, 83 (2013).
[2] S. De Nigris and X. Leoncini, Phys. Rev. E 88, 012131 (2013).
[3] S. de Nigris and X. Leoncini, Phys. Rev. E 91, 042809 (2015).
[4] S. de Nigris, P. Expert, T. Takaguchi and R. Lambiotte, in preparation.

16:30 *Dmitry TODOROV*, Institut de Mathématiques de Marseille (I2M), AMU

Linear response for chaotic 1D maps with an integrable singularity of the derivative

Abstract: Chaotic systems often appear as models of different processes related to statistical physics. From the point of view of foundations of the theory they are somewhat more fair than those used in standard approaches, because they are deterministic, therefore do not require the use of the artificial randomness assumption.
That is why many properties present for systems with randomness are important to check for chaotic systems as well. My talk will be devoted to the linear response property (smooth dependence of the good invariant measure on the parameter) for a particular chaotic system mentioned in the title. Such maps appear in the geometric model of the Lorenz attractor.
I will describe how a special version of perturbation theory applied to the induced dynamics on densities of abs. continuous (w.r.t. Lebesgue) measures, allows to prove (should allow, because it is still work in progress) presence of linear response in this situation.

9:00 *Tobias RIED*, Karlsruhe Intitute of Technology (KIT), Karlsruhe

Analytic smoothing properties of PDE's with a focus on the Boltzmann equation

Abstract: We study regularity properties of weak solutions of the homogeneous Boltzmann equation. While under the so called Grad cutoff assumption the homogeneous Boltzmann equation is known to propagate smoothness and singularities, it has long been suspected that the non-cutoff Boltzmann operator has similar coercivity properties as a fractional Laplace operator. This has led to the hope that the homogenous Boltzmann equation enjoys similar smoothing properties as the heat equation with a fractional Laplacian. We prove that the weak solution of the fully nonlinear non-cutoff homogenous Boltzmann equation with initial datum f0 with finite mass, energy and entropy, $f_0 \in L^1_2(\mathbb{R}^d) \cap L \log L(\mathbb{R}^d)$, immediately becomes Gevrey regular for strictly positive times, i.e. it gains infinitely many derivatives and even (partial) analyticity. This is achieved by an inductive scheme based on very precise estimates of nonlinear, nonlocal commutators of the Boltzmann operator with suitable test functions involving (sub-)exponentially growing Fourier multipliers. (Joint work with Jean-Marie Barbaroux, Dirk Hundertmark, and Semjon Vugalter)

9:30 *Marcel CARRÈRE*, Institut de Neurosciences des Systèmes (INS), AMU

What is Resting state brain and how to explored its dynamics with combined TMS-EEG

Abstract: What is resting state and why we have to study it? I will descride the state of the art about resting state, and how Magnetic Resonnace Imaging (MRI) has characterize networks, also called resting-state networks (RSN). I will explain what we have done to probe these RSN by using TMS-EEG and our first result. (Joint work with M. Bonnard, S. Chen, J. Gaychet, M. Woodman & V. Jirsa.)

10:00 Pause café

11:00 *Mokthar ADDA-BEDIA*, Laboratoire de Physique Statistique (LPS), ENS Paris

Origami mechanics

Abstract: Over the past thirty years, the ancient art of paper folding, or origami, has evolved into an interdisciplinary scientific field. Origami offers the possibility for new metamaterials whose overall mechanical properties can be programmed by acting locally on each crease. Origami metamaterials show for example auxetic behaviour (negative Poisson ratio) and multistability, the latter allowing reprogrammable con_gurations and deployable structures. Starting from a thin plate and knowing the properties of the material and the folding procedure, one would like to determine the shape taken by the structure at rest and its mechanical response. During this talk, I review some recent experimental and theoretical developments on the physics and mechanics of origami-based metamaterials.

11:30 *Davide FARANDA*, Laboratoire des Sciences du Climat et de l'Environnement (LSCE CEA), Saclay

Low-dimensional attractors for the North Atlantic atmospheric circulation

Abstract: Atmospheric ows are characterised by a large number of degrees of freedom. Identifying low-dimensional attractors associated with them is a long-standing challenge, which has severely limited the application of dynamical systems analysis to weather and climate science. We present a novel technique to estimate attractor dimension, and identify an unexpectedly low-dimensional (D = 13) attractor for the large-scale atmospheric circulation in the North Atlantic. We further demonstrate that extremes in the local dimension of the attractor can be linked to high-impact weather events, thus establishing the usefuleness of our technique for climatological studies. The methodology we present is entirely general and may be applied to a diverse range of physical dynamical systems with large degrees of freedom.

12:30 Pause déjeuner

la RECHERCHE à l'Université

CPT
Centre de Physique Théorique

AXE DE RECHERCHE UTLN
Mer Environnement et Développement Durable

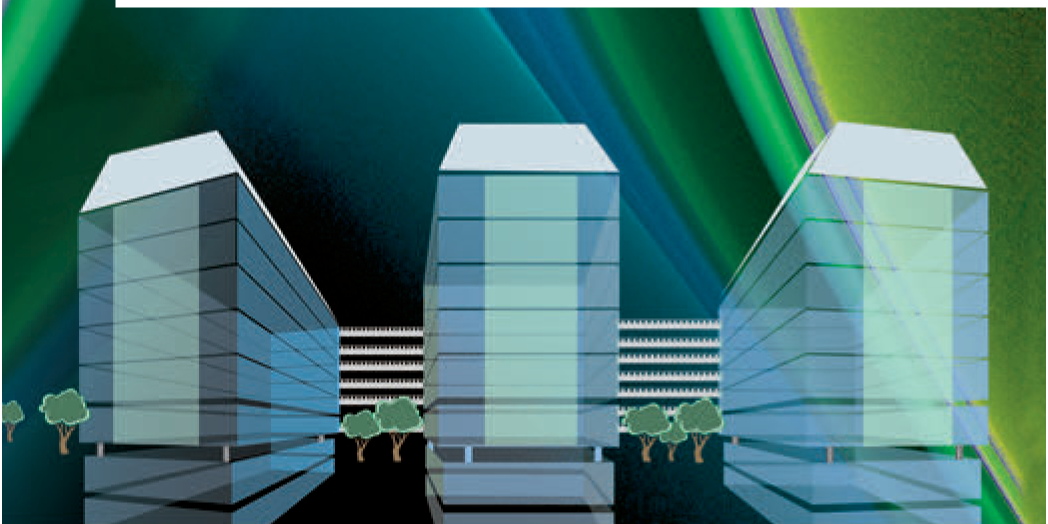
AXE DE RECHERCHE UTLN
Information

Comité d'organisation

Sandro Vaienti • vaienti@univ-tln.fr

Jean-Marie BARBAROUX • jean-marie.barbaroux@univ-tln.fr

Xavier Leoncini • xavier.leoncini@cpt.univ-mrs.fr



Région Provence Alpes Côte d'Azur

Var Le Département

Toulon Provence Méditerranée

http://js2016.univ-tln.fr