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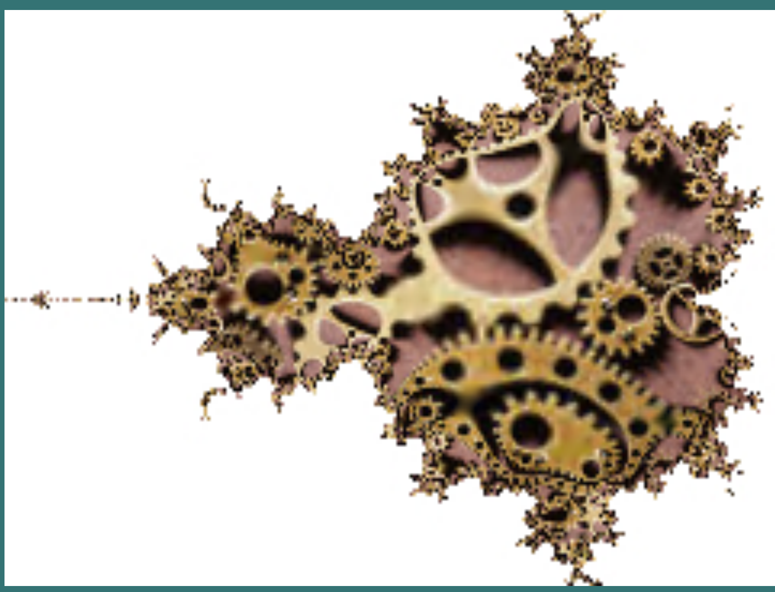

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About

COMPENG

COMPENG is a series of international workshops founded in 2010 aimed at providing a forum for experts and professionals working on the latest developments in complexity science and its application in an engineering perspective. Previous editions of the workshop were held in Rome, Italy (2010); Aachen, Germany (2012); Barcelona, Spain (2014); Catania, Italy (2016).

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Timetable

CT: Contributed Talk, IS: Invited Speaker, KL: Keynote Lecture.

Wednesday, 10 of October

8:30–9:00	**Registration**		
9:00–9:30	**Opening**		
	Plenary session [Chair: Duccio Fanelli] - Room A		
9:30–10:15	KL	**Antonio Politi**	Use of permutation entropy in the analysis of complex time series
10:15–11:00	KL	**Giovanni De Ninno**	Generation of femtosecond extreme-ultraviolet optical vortices
11:00–11:20	**Coffee break**		
	Laser dynamics and nonlinear optical systems [Chair: Riccardo Meucci and Francesco Marino] - Room A		
11:20–11:40	CT	**Stephane Barland**	Experimental analysis and mean-field dynamics of a fully connected network of spiking neuromorphic optical devices
11:40–12:00	CT	**Gian Luca Lippi**	Nonlinear dynamics at the meso- and nanoscale: stochasticity meets determinism
12:00–12:20	CT	**Silvia Soria**	Parametrical Optomechanical Oscillations: transition to chaos
11:40–12:00	CT	**Marco Ciofini**	Self imaging configurations for passive global Coherent Laser Beam Combining
12:00–12:20	CT	**Kais Al Naimee**	Encrypted Chaos In Quantum Dot Light Emitting Diode
13:00–14:00	**Lunch**		

	Data and time series analysis **[Chair: Mattia Frasca] - Room A**		
14:00–14:20	CT	**Angelo Di Garbo**	Inferring coupling intensity and directionality between time series
14:20–14:40	CT	**Elbert E. N. Macau**	Detecting causal relations from real data experiments by using recurrence
14:40–15:00	CT	**Sanjivani Bhabad**	Parameter Estimation Using HMM for Disordered Speech
15:00–15:20	CT	**Mauro Focardi**	The PLATO Payload and Data Processing System SpaceWire network
15:05–15:30	**Coffee break**		
	Biophysics **[Chair: Valentina Gambuzza] - Room A**		
15:40–16:00	CT	**Riccardo Cicchi**	Polarization-modulated SHG microscopy allows probing the supramolecular symmetry of collagen
16:00–16:20	CT	**Francesco Piazza**	Non-equilibrium chemical kinetics: insight into prebiotic chemistry
16:20–16:40	CT	**Daniele Farnesi**	Fractal-radiomics as complexity analysis of CT and MRI cancer images
16:40–17:00	CT	**Giulia Bassignana**	Identification of Driver Nodes in Genetic Networks Regulating Macrophage Activation

Thursday, 11 of October

		Plenary session [Chair: Massimo Materassi] - Room A	
9:00–9:45	KL	**Philippe Ghendrih**	Challenges in addressing the complex path towards fusion energy
9:45–10:30	KL	**Nadia Dominici**	Modular control of human locomotion
10:30–10:50		**Coffee break**	
		Synchronization [Chair: Francesca Di Patti] - Room A	
10:50–11:10	CT	**Alessio Cardillo**	Coevolution of synchronization and cooperation in costly networked interactions
11:10–11:30	CT	**Lucia V. Gambuzza**	Remote synchronization in tree structures of Stuart-Landau oscillators
11:30–11:50	CT	**Simona Olmi**	Qualitative Stability and Synchronicity Analysis of Power Network Models in Port-Hamiltonian form
11:50–12:10	CT	**Alessandro Torcini**	Transition from asynchronous to oscillatory dynamics in balanced spiking networks with instantaneous synapses
12:10–12:30	CT	**Li-Qun Chen**	Cluster synchronization via sliding control of uncertain node-colored complex networks
		Invited special session “Controller and Power Hardware-in-the-Loop (C/PHIL) Simulation of Electric Power Apparatus and Control Theory and Practice” [Chairs: Georg Lauss and Mischa Steurer] - Room B	
10:50–11:10	IS	**Ustun Taha Selim**	Using RSCAD’s Simplified Inverter Components to model Smart Inverters in Power Systems
11:10–11:30	IS	**Marija Stevic**	A Bilateral Teleoperation Approach for Interface Algorithms in Distributed Real-Time Simulations
11:30–11:50	IS	**Christian Dufour**	Highly stable rotating machine models using the state-space-nodal real-time solve

11:50–12:10	IS	**Ron Brandl**	Advanced Testing Chain Supporting the Validation of Smart Grid Systems and Technologies
12:10–12:30	IS	**Joern Geisbuesch**	Set-up of a Dynamic Multi-purpose Power-Hardware-in-the-Loop System for New Technologies Integration
12:30–12:50	IS	**Shahab Karrari**	Frequency and Voltage Support by a High-speed Flywheel Energy Storage System (FESS): A Real-time Simulation for Hardware-in-the-Loop (HIL) Testing
12:30–13:30	**Lunch**		
13:30–14:30	**Poster session**		
	Nonlinear dynamics and stochastic processes 1 [Chair: Simona Olmi] - Room A		
14:30–14:50	CT	**Sarah De Nigris**	Graph Semi-Supervised Learning through bridgeness biased random walks
14:50–15:10	CT	**Mattia Frasca**	On using Feynman-Sierpinski resonators to obtain high-dimensional chaos in a single-transistor oscillator
15:10–15:30	CT	**Jean-Marc Ginoux**	Torus Breakdown in a Uni Junction Memristor
15:30–15:50	CT	**Graziano Chesi**	On the Complexity of Robust Stability Analysis of Polytopic LTI Systems
15:50–16:10	**Coffee break**		
	Nonlinear dynamics and stochastic processes 2 [Chair: Francesco Marino] - Room A		
16:10–16:30	CT	**Massimo Materassi**	Metriplectic Structure of a Radiation-Matter Interaction Toy Model
16:30–16:50	CT	**Jose A. Roversi**	The role of the instabilities on the quantum entanglement generation
16:50–17:10	CT	**Giacomo Innocenti**	Frequency analysis of complex dynamics in memristive circuits

17:10–17:30	CT	**Matteo Morini**	A Simple Model of Coevolution for Macroscopic and Microscopic Levels
17:30–17:50	CT	**Sara Nicoletti**	Non normal amplification of stochastic quasi-cycles
16:10–18:00	**Meeting of the IEEE Working Group Recommended Practice for Hardware-in-the-Loop Simulation Based Testing of Electric Power Apparatus and Controls [Chairs: Mischa Steurer, Georg Lauss and Blake Lundstrom] Room B**		
20:00	**Social Dinner**		

Friday, 12 of October

	Complex networks 1 [Chair: Giacomo Innocenti] - Room A		
9:00–9:20	CT	**Zuzana Borcinova**	Solving the Capacitated Vehicle Routing Problem by a Parallel Micro Genetic Algorithm
9:20–9:40	CT	**Peter Czimmermann**	Computation of Transportation Performance in Public Service Systems
9:40–10:00	CT	**Lubos Buzna**	Collective Effects and Performance of Algorithmic Electric Vehicle Charging Strategies
10:00–10:20	CT	**Jaroslav Janacek**	Online Learning Search for Stackelberg Game Strategy
10:20–10:40	CT	**Pere Colet**	Secondary control may prevent Braess' paradox in AC power grids
10:40–11:00	CT	**Violet Mwaffo**	A data-driven method to dissect the dynamics of the causal influence in complex dynamical systems
11:00–11:20	**Coffee break**		

	Complex networks 2 **[Chair: Giulia Cencetti] - Room A**		
11:20–11:40	CT	**Charles R. Farrar**	A Complexity-Based Framework for Structural Health Monitoring
11:40–12:00	CT	**Ihusan Adam**	Reactive explorers to unravel network topology
12:00–12:20	CT	**Franco Bagnoli**	Risk perception and epidemics in complex computer networks
12:20–12:40	CT	**Zakaria Ghalmane**	Betweenness Centrality for Networks with Non-Overlapping Community Structure
12:40–13:00	CT	**Onur Senturk**	Agent-based model and simulations of the management of ports: the import processes at the port of Genoa
13:00–14:00	**Lunch**		

List of Abstracts – Talks

Wednesday 10th

Use of permutation entropy in the analysis of complex time series

A. Politi **KL**

Institute for Complex Systems and Mathematical Biology, Old Aberdeen, Scotland (UK)

Permutation entropy, a tool based on the relative order of consecutively sampled data, is commonly used to characterize the dynamical complexity of generic irregular time series. I will show that the effectiveness of the tool can be greatly enhanced by complementing its computation with that of an additional indicator, based on the mutual spreading of trajectories characterized by the same symbolic encoding. In particular the numerical estimate of Kolmogorov-Sinai entropy can be significantly improved.

Generation of femtosecond extreme-ultraviolet optical vortices

G. D. Ninno[1], M. Smith[2,3] **KL**

University of Nova Gorica, Slovenia.

Optical vortices are currently one of the most intensively studied topics in optics. These light beams, which carry orbital angular momentum (OAM), have been successfully utilized in the visible and infrared in a wide variety of applications. Moving to shorter wavelengths may open up completely new research directions in the areas of optical physics and material characterization. Here, we report on the generation of extreme-ultraviolet optical vortices with femtosecond duration carrying a controllable amount of OAM. From a basic physics viewpoint, our results help to resolve key questions such as the conservation of angular momentum in highly nonlinear light–matter interactions, and the disentanglement and independent control of the intrinsic and extrinsic components of the photon's angular momentum at short-wavelengths.

Experimental analysis and mean-field dynamics of a fully connected network of spiking neuromorphic optical devices

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[2] CNR - Istituto Nazionale di Ottica, largo E. Fermi 6, I-50125 Firenze, Italy
[3] Université Côte d'Azur-INRIA, MathNeuro Team, 2004 Route des Lucioles-BP 93, 06902, Sophia Antipolis, France

We analyze experimentally and theoretically the dynamics of an ensemble of about five hundred coupled spiking elements. We show that the fully connected network can behave as a low dimensional chaotic system.

Nonlinear dynamics at the meso- and nanoscale:

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[1] School of Electronics and Information,Hangzhou Dianzi University,Hangzhou, China
[2] Istituto dei Sistemi Complessi,CNR,Sesto Fiorentino, Italy
[3] Institut de Physique de Nice,Université Côte Azur,Sophia Antipolis, France

Application-driven technological progress has led to the realization of lasers whose cavity volume is below one cubic emission wavelength. Such nanodevices possess features which differ from those of standard, macroscopic lasers, such as thresholdless behaviour. We discuss the dynamics in lasers ranging from the mesoscale down to the nanoscale and highlight the impact of noise on the operation of systems below the macroscopic scale. Experimental and modeling issues are discussed, together with the needs for interpretative tools geared towards the investigation of these new devices, which are poised to play a substantial role in future applications and in the study of the dynamics of small systems, at the crossing points between determinism, stochasticity, finite size, and quantum effects.

Parametrical Optomechanical Oscillations: transition to chaos

X. Roselló-Mechó[1], D. Farnesi[2], A. Barucci[2], G. Frigenti[2], A. F. Bienes[3], F. Ratto[2], M. Delgado-Pinar[1], M. V. Andrés[1], T. G. Fernandez[4], G. N. Conti[1], S. Soria[1]

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[3] UNAM, Universidad Nacional Autónoma de México, Mexico City, Mexico
[4] Universidad Autónoma de la Ciudad de México (UACM), Mexico City, Mexico

Whispering gallery mode resonators (WGMR) have attracted a great interest in the last decade. WGMR have been fabricated in different geometries, solid and hollow, spherical, toroidal, and bottled shaped. Hollow spherical WGMR or microbubble resonators (MBR) are the last arrived in the family of resonators. The approach used for their fabrication is based on surface tension driven plastic deformation on a pressurized capillary [1], similar to glassblowing. Using such technique we are able to fabricate large surface area and thin spherical shells with high quality factor (Q). MBR are efficient phoxonic cavities that can sustain both optical photons and acoustic phonons [2]. It has been demonstrated that MBR can be used to study Turing comb patterns (Kerr modulation) and Stimulated Brillouin Scattering (SBS) [3,4]. The acoustic phonons responsible of SBS are related to the material, and they are in the GHz range for bulk silica. Radiation pressure is another mechanism that also leads to excitation of acoustic phonons with lower frequencies, in the range of hundreds of kHz to tens of MHz in the case of silica MBR. The frequency of such oscillations occurs very close to the mechanical eigenfrequencies of the cavity. Similar to toroidal and solid spherical WGMR [5], MBR show a similar route to chaos: periodic doubling bifurcation and a set of discrete lines into a continuum, and finally a continuum.[6] For very large MBR, the transition to chaos is direct, avoiding the sequences of periodic doubling bifurcations. We have also studied the temporal behavior of the cavity, the coexistence and the suppression of the oscillation while generating Turing comb patterns. The oscillation suppression occurs when the light is coupled to the resonance with red detuning (the pump has a lower frequency than the resonance). In this case, we generate photons in other resonant modes equally spaced (four wave mixing processes). The observed phenomenology can be explained by the geometrical characteristics of a MBR. MBRs are spheroidal WGM resonators with quite dense spectral characteristics. The geometrical dispersion is normal and large with values of several hundreds of kHz. However, the material dispersion is quite large at the wavelengths considered in this work. The total dispersion is anomalous and large, also with values of several hundreds of kHz, as expected for very large MBR. Thus, Kerr comb formation is allowed for all MBR used in this work.

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Self imaging configurations for passive global

A. Lapucci, M. Ciofini

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Abstract—Parallel Laser Beam Combining is widely studied as a mean to overcome the physical limits of single laser sources. It can be obtained by injection coupling of several independent laser resonators. This of course represents a complex dynamical problem, the individual lasers being non-linear oscillators. Stable single phase solutions can be obtained for the entire system of lasers as well as local domains of phase-locked elements or chaotic behaviors. In passive systems the elements locking can be pursued by means of next-neighbor coupling or global feedback. We study self-imaging optical schemes for global feedback Coherent Beam Combining (CBC). We propose guided configurations to overcome edge-losses typical of this approach. Numerical Simulations indicate this as a viable solution for fiber lasers CBC.

Encrypted Chaos In Quantum Dot Light Emitting Diode

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We demonstrate the existence of chaotic behavior in the Dynamics of a Quantum Dot Light Emitting Diode (DQD-LED) with Filtered Optical Feedback (FOF)[1,2].The underlying dynamics is affected by a Saddle Node(SN), which returns to an elliptical shape when the Wetting Layer (WL) is neglected. Both filter width and Time Delay (TD) changes the appearance of different dynamics schemes (Chaotic and Mixed Mode Oscillations (MMOs). The addition of small parametric harmonic perturbations with adjustable Phase Control (PC) is examined both by changing frequency and strength of the controlling perturbation [3]. A communication scheme based on the synchronization of two chaotic quantum dot light emitting diodes (QD-LEDs) is theoretically examined. Chaos in the QD-LED is generated by means of an Optical Feedback (OF). Synchronization of chaos is obtained by varying the coupling strength between the transmitter and the receiver in a unidirectional coupling scheme. We then test three communication schemes by successfully transmitting messages.

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Inferring coupling intensity and directionality between time series

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One of the most important problems in nonlinear time series analysis is that of detecting the level of interdependence between a pair of signals and the corresponding coupling directionality. This can be achieved by using some specific methods, which are typically chosen in close relationship to the nature of data and to the specific applicative context. Today, the large availability of data from different disciplines, like biology, physics etc..., requires very efficient and robust algorithms for their analysis and this stimulate the search for new nonlinear time series analysis methods. In line with this framework, in our contribution we propose a new method to detect linear and nonlinear correlations between a pair signals and the corresponding coupling directionality. This method is called the Boolean Slope Coherence (BSC) and its performance was evaluated on bivariate time series generated with different linear and nonlinear models. In addition, a comparison of the BSC method with other well-known methods to detect coupling intensity was also performed and the corresponding results will be discussed. Similarly, the capability of the BSC method to assess coupling directionality was also tested by the comparison of its performance with that of other methods. Overall, it will be show that the BSC method can be employed successfully to quantify the coupling level between pair of signals and the corresponding directionality. Lastly, it will be show that the BSC algorithm works well also for signals contaminated by noise. Finally, will be presented and discussed some results of the application of the BSC method to neurophysiological recordings from visual and motor cortices.

Detecting causal relations from real data experiments

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[3] Potsdam Institute for Climate Impact Research, Potsdam 14473, Germany.

In this work, we present the Recurrence Measure of Conditional Dependence (RMCD), a recent data-driven causality inference method using the framework of recurrence plots. The RMCD incorporates the recurrence behavior into the transfer entropy theory. We apply this methodology to some paradigmatic models and to investigate the possible influence of the Pacific Ocean temperatures on the South West Amazon for the 2010 and 2005 droughts. The results reveal that for the 2005 drought there is not a significant signal of dependence from the Pacific Ocean and that for 2010 there is a signal of dependence of around 200 days. These outcomes are confirmed by the traditional climatological analysis of these episodes available in the literature and show the accuracy of RMCD inferring causal relations in climate systems.

Parameter estimation using HMM for disordered speech

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As per the level of deafness, the deaf people suffer while talking as they cannot hear properly. So they cannot communicate their thoughts, feelings and express abilities of things properly. Automatic speech recognition (ASR) supports to overcome these problems. However, the ASR is also having some difficulties to solve these problems because of complexity of speech processing like variations in temporal and spectral domain. To retrieve these temporal and spectral characteristics of speech most commonly used statistical model is Hidden Markov Model (HMM). Gaussian mixture estimator of HMM models these temporal variations with local spectral variability modeled using flexible distributions. Thispaper proposed a prediction model using HMMto recognize the speech for articulatory handicapped people and compares the performance of this model with the recognition accuracy of normal speech. Mel Frequency Cepstral Coefficient (MFCC) is used as feature extraction technique as it has high robustness. The recognition accuracy of speech for articulatory handicapped people is 77.2

The PLATO Payload and Data Processing System SpaceWire network

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PLATO [1] has been selected and adopted by ESA as the third medium-class Mission (M3) of the Cosmic Vision Program, to be launched in 2026 with a Soyuz-Fregat rocket from the French Guiana. Its Payload (P/L) is based on a suite of 26 telescopes and cameras in order to discover and characterise, thanks to ultra-high accurate photometry and the transits method, new exoplanets down to the range of Earth analogues. Each camera is composed of 4 CCDs working in fullframe or frame-transfer mode. 24 cameras out of 26 host 4510 by 4510 pixels CCDs, operated in full-frame mode with a pixel depth of 16 bits and a cadence of 25 s. Given the huge data volume to be managed, the PLATO P/L relies on an efficient Data Processing System (DPS) whose Units perform images windowing, cropping and compression. Each camera and DPS Unit is connected to a fast SpaceWire (SpW) network running at 100 MHz and interfaced to the satellite On-Board Computer (OBC) by means of an Instrument Control Unit (ICU), performing data collection and compression.

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Polarization-modulated SHG microscopy allows probing the supramolecular symmetry of collagen

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The morphological features of biological connective tissues mainly depend on collagen supramolecular assembly and composition. The supramolecular organization of collagen plays a crucial role in various pathologies, including fibrosis and cancer metastasis. The aim of the present study is to highlight the supramolecular features of collagen morphology in human tissues. In particular, the supramolecular organization of collagenous corneal stroma was characterized at the sub-micron scale using polarization-modulated Second-Harmonic Generation (P-SHG) microscopy within both healthy corneal stroma and breast cancer samples. Within the corneal tissue, the obtained results demonstrated that a particular class of lamellae, located in the anterior part of the cornea, exhibits a particular supramolecular organization that differ significantly from other corneal lamellae located deeper into the tissue. This class of lamellae is probably responsible of corneal stiffness, as demonstrated by their altered morphology in keratoconus, a pathology that features a loss of corneal stiffness. The confirmation of an altered corneal stiffness was provided by an additional analysis of the sample using Brillouin micro-spectroscopy. The interesting correlation found between morphological and stiffness data promises a potential successful application of this experimental approach to study collagen in different biological tissues as well as in various physiological and pathological conditions. In fact, the test of the biochemical model carried out on breast cancer samples demonstrated a different supramolecular organization of collagen was found in the pathological stroma, in comparison to healthy stroma. In particular, the typical collagen supramolecular trigonal symmetry, associated with higher stiffness, was found in healthy collagen, whereas a cylindrical symmetry, associated with lower mechanical stiffness was preferably found within pathological stroma. In conclusion, our method is able to assess connective tissue

morpho-mechanics with a labelfree contact-less modality and offers the potential for being extended to the analysis of several biological and synthetic materials.

Non-equilibrium chemical kinetics:

F. Piazza, T. Georgelin

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Life is an intrinsic non-equilibrium phenomenon, where a system consumes energy and relies on specific dissipation channels to dump energy into the surrounding and maintain its highly organized functional non-equilibrium steady state. By the same token, increasing attention is being paid to the role of nonequilibrium conditions on the kinetics of prebiotic earth chemical reactions, such as steady gradients of temperature, PH or chemical potential. In this talk, I will concentrate on the effect of steady temperature gradients on the chemistry of D-ribose isomerization and ATP thermal hydrolysis, two important problems in prebiotic chemistry. By discussing the results of NMR experiments and statistical physics calculations, we will argue that the strong non-equilibrium conditions found in prebiotic earth environments might have been instrumental to the foundation of the chemistry of life, by overcoming the constraints imposed by equilibrium thermodynamics.

Fractal-radiomics as complexity analysis of CT and MRI cancer images

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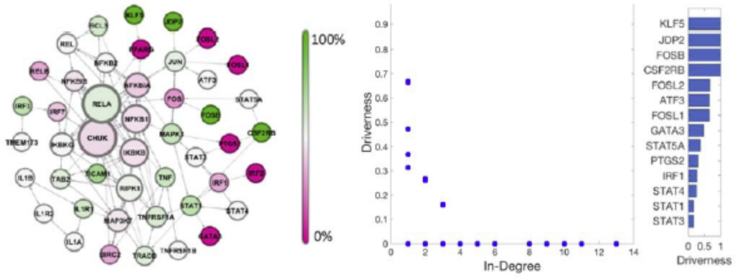
Cancer is the second leading cause of death globally. Early diagnosis can allow intervention to reduce mortality but due to cancer complex structure and spatial heterogeneity among different tumors and within each lesion, it is difficult to differentiate it from healthy tissue using conventional imaging techniques. Quantification of its complexity can be a prognostic tool for fighting this disease. In recent years, clinical imaging allows this quantification thanks to Radiomics, which extracts features from images. In this study, Fractal Dimension (FD) and Lacunarity (L) in computed tomography (CT) and magnetic resonance (MR) images for different kinds of cancer were examined using box counting method. Our aim is to highlight the potentiality of features based on fractal analysis, in order to obtain new indicators able to detect tumor spatial complexity and heterogeneity. The results indicated that both FD and L show problems linked to the lack of connection between complexity estimated with Radiomics and the underlying biological model.



(a) Inferred graph. (b) Driverness over in-degree. (c) Ranking.

Figure 0.1: (a) Inferred network of genes involved in phosphorylation, 46 nodes and 168 directed edges. Size of the nodes corresponds to their degree, color to percentage of outgoing links. (b) Driverness of the nodes over their in-degree. (c) Genes ranked by driverness.

Identification of Driver Nodes in Genetic Networks Regulating Macrophage Activation

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Macrophage cells play an important role in the Multiple Sclerosis disease. They are known to participate both to the degenerative process, myelin destruction, and to the regenerative one, coordinating remyelination. The correct genetic activation of macrophage phenotypes permits a correct remyelinating response [1], thus the possibility to steer it towards an healthy state while acting on a limited number of genes (drivers) would be greatly advantageous. We modeled macrophage activation as a network (Figure 0.1), where nodes correspond to genes involved in phosphorylation and directed links corresponded to significant activations as retrieved from the STRING Database [2]. We adopted the structural controllability framework [3], mapping the Kalman controllability criterion into the maximum cardinality matching on a graph, to identify the driver nodes. Because different configuration of driver nodes are in general possible, we repeated the analysis R=60000 times and shuffled the order of the nodes in the adjacency matrix in order to explore different configurations. We defined the node driverness as the frequency of times a nodes is selected as driver over R iterations. Our work is a preliminary step towards the identification of the genes influencing the inflammatory process of macrophages, a crucial mechanism in multiple sclerosis' disease.

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Thursday 11th

Challenges in addressing the complex path towards fusion energy

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Fusion energy combines many inspiring issues of interest for society. In the last decade new challenges and hopes pave the way forward for engineers and scientists. The possibility of controlling thermo-nuclear reactions and generating energy is driving this research activity. This would be a major step for humanity. The present effort is concentrated on the building of the ITER tokamak by the international community in Cadarache (France), development of companion experiments and the new challenges opened by the increase of numerical simulation capability. The presentation will address three aspects of complexity if fusion energy research. First, the basics of thermonuclear fusion energy are revisited underlying the assets and constraints. Second, the complexity of the ITER project is presented. Stepping towards the first plasma is an impressive combination of political and social complexity as well as a major challenge for engineering. For the scientists it is also a critical step into experiments with a nuclear grade device. This imposes numerous trades-offs and clear answers to numerous simple questions, a time when the comfort of complexity must give way to the constraints and facts that rule the operation of a nuclear device. Third, the scientific complexity of controlling the performance of burning plasma is addressed in view of the numerical simulation effort. Key problems that are addressed are (i) the impact of plasma turbulence on transport and therefore the quest for enhanced performance, (ii) the determination and control of the boundary layer that governs the interaction of the plasma with vessel components, (iii) optimisation of operation and design. It is striking that the issue is the complexity of infinitely normal problems. Indeed the scales and particles energies allow us to address the physics as a classical system while the self-organisation, interaction between disparate scales, bifurcation between various states, drive a difficulty in modelling and understanding akin to many problems of our daily life. In that respect, connection to research activity outside fusion will be highlighted.

Modular control of human locomotion

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In order to walk we must set into motion the body and the legs using literally hundreds of different muscles. The idea that the CNS may control these complex interactions between muscles by using a small number of elementary commands has received considerable attention. We explored this idea for human locomotion by examining this modular organization, including the development of walking in children. When neonates are supported for 70-80% of their weight, they instinctively 'walk' as their feet come into contact with a horizontal surface. This 'stepping reflex' is hardwired in our neural circuitry, however, in normally developing children the ability to walk independently emerges only about one year later. I will discuss how the number and type of the elementary locomotor commands change with development in animals and humans. I will then present another example of this modular organization that is used to develop a new rehabilitation technique to restore walking in patients with spinal cord injury.

Coevolution of synchronization and cooperation in costly networked

A. Antonioni, A. Cardillo

The synchronization of coupled oscillating systems has received considerable attention from the scientific community given its wide range of applications [1]. The pattern of interactions among the oscillators plays a crucial role in triggering the onset of the synchronized state and, over the years, several studies have investigated the emergence of synchronization in populations of oscillators arranged as a network [2]. Despite that, the hypothesis that interactions bear a cost has been considered seldom. The introduction of costly interactions leads, instead, to the formulation of a dichotomous scenario in which an agent may decide to cooperate and pay the cost in order to get synchronized with the rest of the population, or free ride waiting for others to get synchronized with her state without paying any cost. Hence, the spontaneous emergence of synchronization may be seen as the byproduct of an evolutionary game in which individuals decide their behavior according to the benefit/cost ratio they accrue in the past. This leads to a coevolutionary approach where the synchronization dynamics and the evolution of cooperation are intertwined together. Complex networks play also a fundamental role in the onset of cooperation, with hubs bolstering such phenomenon. Therefore, it is worth investigating the underlying mechanisms responsible for the onset of cooperation/synchronization in systems where the oscillators correspond to the nodes of a network. In Fig. 0.2, we display the overall behavior of a set of evolutionary Kuramoto oscillators arranged using three different network models. We observe the presence of a region of the parameter space where both cooperation and synchronization emerge, as well as the presence of regions where the former is present without the latter. The results of our study are summarized in [3].

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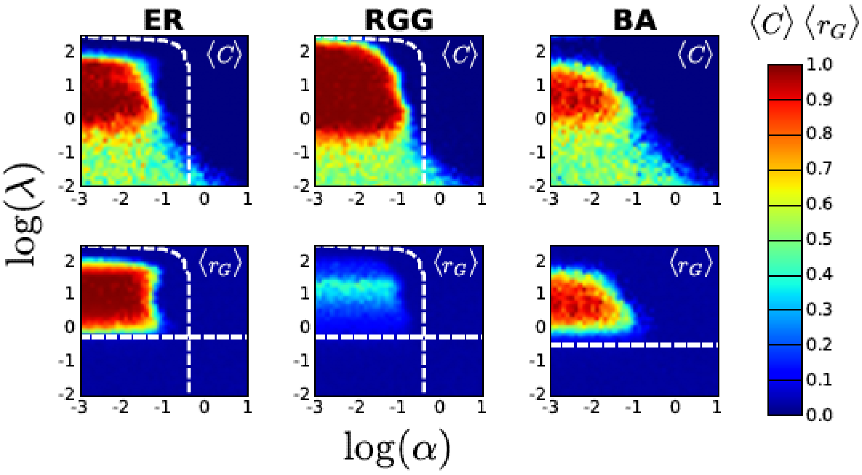

Figure 0.2: Overall emergence of cooperation/synchronization. The top (bottom) row illustrates the average level of cooperation (synchronization) $\langle C \rangle (\langle r_G \rangle)$ as a function of the coupling strength λ and relative cost α. Each column corresponds to a different topology, namely: Erdos-Renyi (ER) random graphs, Random Geometric Graphs (RGG) and Barabasi-Albert (BA) scale-free.

Remote synchronization in tree structures of Stuart-Landau oscillators

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Understanding the way in which units, interacting through a network, arrange themselves and give rise to different collective behaviors is the aim of a large body of literature in nonlinear dynamics. In particular, recent studies have shed light on how the topology influences the dynamics, and how particular states, such as cluster or chimera states, could be induced by acting on the topology [4]. However, less has been said about situation wherein the final complex patterns are not only related to the underlying structure, but are also the result of hidden mechanisms. Among all, one of the most intriguing phenomena is remote synchronization (RS), wherein distant network units, i.e., not directly connected, interact in such a way as to form groups of synchronized nodes. From the first evidence in star-like networks [1], RS has been revealed in more complex structures [2] and in networks with symmetries [3]. In this work, we investigate RS in tree structures in order to gain insights into the mechanisms underlying this phenomenon in a topology with controlled characteristics. In particular, we investigate the role of the length of the chains originating from the root node, discovering non-trivial effects which can have analogies with the behaviors of social systems with hierarchical organizations. Our analysis is carried out by means of an experimental setup based on custom electronic boards implementing the dynamics of Stuart-Landau oscillators with fully reconfigurable coupling, whose strength is controlled by digital potentiometers. In addition, several parameters of the single cell dynamics can be easily reconfigured so that to implement mismatched nodes at different hierarchical levels. Our experiments reveal a not-stereotyped transition from RS to global synchronization, contrarily to what was previously observed in star-like networks [1]. In fact, while for star-like networks global synchronization gradually emerges from RS, trees with long chains of children yield a transition with a non-monotonic evolution of the level of RS, a result that suggests the presence of competition between local and global synchronization properties. **References**

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Qualitative Stability and Synchronicity Analysis of Power Network Models in Port-Hamiltonian form

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The increased percentage of renewable energies, such as wind and solar power, and the decentralization of power generation makes the stability and synchronization control of modern power systems increasingly difficult. To address different control and optimization tasks, there are many different approaches to model power networks; we will briefly present a power grid model hierarchy of differential-algebraic systems. At the lowest levels of such a model hierarchy simplified nonlinear network models like the Kuramoto model are placed which are often used for a qualitative analysis of the network behavior [1,2]. The usual formulation of the Kuramoto model in form of a coupled system of ordinary differential equations as in [1-8] is, however, not always appropriate, because physical properties like the conservation of energy and momentum, or Kirchoff's node conditions are only implicity represented in the equations, and thus in numerical simulation or control methods they may be violated and lead to unphysical behavior. To prevent this, we present a new energy-based formulation of the Kuramoto model as port-Hamiltonian system of differential-algebraic equations. This model is a very robust representation of the system with respect to disturbances, since it encodes the underlying laws of physics in the algebraic and geometric structure of the equations. It allows the development of structure preserving methods that satisfy the physical laws after discretization and in finite precision arithmetic leading to robust simulation and control methods. The energy-based modeling approach allows for easy model refinement, as well as interconnection with other systems from different physical domains. In particular, due to its systematic energy based formulation the model class allows easy extension, when further effects have to be considered, higher fidelity is needed for qualitative analysis, or the system needs to be coupled in a robust way to other networks. We illustrate the new modeling approach with analytic results and numerical experiments and indicate how this approach can be generalized to also allow quantitative analysis. We introduce a novel order parameter, that takes into account the topology of the underlying network to better estimate the level of synchronization present in the network. In particular it turns out that the new order parameter is more robust in limiting situations, like the transition to synchronization and when chaos is present in the network. We also illustrate the advantage of the port-Hamiltonian formulation in the preservation of conserved quantities. The new approach and its advantages have been illustrated with many numerical examples carried out for a semi-realistic model of the Italian power grid [9]. Future work will include the analysis of the whole model hierarchy, error control in adaptive time step and model selection, as well as model reduction techniques that allow real time stabilization and synchronization as well as the incorporation of switching in and time-delay in the model.

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Transition from asynchronous to oscillatory dynamics in balanced spiking networks

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Cortical neurons fire quite irregularly and with low firing rates, despite being subject to a continuous bombardment from thousands of pre-synaptic excitatory and inhibitory neurons [1]. This apparent paradox can be solved by introducing the concept of balanced network, where excitation and inhibition balance each other and the neurons are kept near their firing threshold [2]. In neural network models balance can emerge spontaneously in coupled excitatory and inhibitory populations thanks to the dynamical adjustment of their firing rates [3–8]. The usually observed dynamics is an asynchronous state characterized by irregular neural firing joined to stationary firing rates [3, 5, 6]. The asynchronous state has been experimentally observed both in vivo and in vitro [9], however this is not the only state observable during spontaneous cortical activity. In particular, during spontaneous cortical oscillations excitation and inhibition wax and wane together [10], suggesting that balancing is crucial for the occurence of these oscillations with inhibition representing the essential component for the emergence of the synchronous activity [11]. The emergence of collective oscillations (COs) in inhibitory networks has been widely investigated in net-works of spiking leaky integrate-and-fire (LIF) neurons. In particular, it has been demonstrated that COs emerge from asynchronous states via Hopf bifurcations in presence of an additional time scale, beyond the one associated to the membrane potential evolution, which can be the transmission delay [4] or a finite synaptic time [12]. As the frequency of COs is related to such external time scale this mechanism is normally related to fast (>30 Hz) oscillations. Nevertheless, despite many theoretical studies, it remains unclear which other mechanisms could be invoked to justify the broad range of COs frequencies observed experimentally [13]. We present a novel mechanism for the emergence of COs in balanced spiking inhibitory networks in absence of any synaptic or delay time scale. In particular, we show for class I and II neurons that COs arise from an asynchronous state by increasing the network connectivity (in-degree). Furthermore, we show that the COs can survive only in presence of irregular spiking dynamics due to the dynamical balance. The origin of COs can be explained by considering the phenomenon at a macroscopic level, in particular we extend an exact mean-field formulation for the spiking dynamics of Quadratic Integrate-and-Fire (QIF) neurons [14] to sparse balanced networks. An analytic stability analysis of the mean-field model reveals that the asymptotic solution for the macroscopic model is a stable focus and determines the frequency of the associated relaxation oscillations. In the network the irregular microscopic firing of the neurons is able to sustain COs, corresponding to the relaxation dynamics towards the macroscopic focus. This mechanism elicits COs through the excitation of an internal macroscopic time scale, that can range from seconds to tens of milliseconds, yielding a broad range of collective oscillatory frequencies. We then analyze balanced excitatory-inhibitory populations revealing the existence of COs characterized by two incommensurate frequencies, whose emergence is due, also in this case, to the excitation of a mean-field focus induced by fluctuation-driven microscopic dynamics.

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Cluster synchronization via sliding control of uncertain node-colored complex networks

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In this paper, complex networks with community structure and colored nodes are investigated. The cluster synchronization of these networks is studied by sliding mode control schemes. Based on Lyapunov stability theory, adaptive control gains and several sufficient conditions for the network to achieve cluster synchronization are derived. Especially, we are free to choose the clustering topologies, the cluster number and the node number in each cluster. Numerical simulations presented to show the application of the theoretical results.

Using RSCAD's Simplified Inverter Components to

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There is growing interest in Smart Inverters (SIs) thanks to their capabilities of providing auxiliary support. Power companies are interested in deploying them in their networks to get necessary frequency and voltage support at times of need. However, these inverters dynamically exchange real and reactive power with the grid and try to change operating point of the system. This dynamic behavior at the distribution level of the power systems may create unprecedented problems. In order to test their impact on the network, hardware-in-the-loop (HIL) testing is preferred. HIL tests give higher fidelity than simulation-only studies and can model real power networks to study a particular phenomenon. With a combination of real SI hardware and power system modeled in software, different operating modes and their impact on the system can be investigated thoroughly. It is a real challenge to model several SIs in a distribution network as they require small time step modeling which limits computing capacity of real-time simulation platforms such as RTDS. In order to circumvent this issue, simplified inverter models in RSCAD are utilized to model SI functions such as Volt-Var or Power Factor control. With this approach, individual switches within an inverter are not modeled and phenomena that are resulting from rapid switching, such as harmonics, are not taken into account. For studies that focus on the power flow control or voltage support, this trade off is acceptable as many SIs can be easily implemented within a network.

A Bilateral Teleoperation Approach for Interface

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Distributed simulation has an emerging role in enabling flexible environment for assessment of next-generation power systems. Geographically distributed real-time simulation (GD-RTS) environment established by virtual interconnection of Digital Real-Time Simulators (DRTS) located at geographically dispersed laboratories allows for holistic testing of novel devices and concepts. Main challenges associated with establishing GDRTS environment are ensuring simulation stability and providing simulation fidelity of high degree. The issue of designing a cosimulation Interface Algorithm (IA) that meets these requirements is closely related to the bilateral teleoperation concept in robotics. In this work we analyze applicability of wave variables, one of the most widely used method for bilateral teleoperation. Wave variables ensure simulation stability in presence of large time delays. Simulation fidelity of IA has been improved by introducing transformation of wave variables to dynamic phasor domain.

Highly stable rotating machine models

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This paper presents a set of rotating machine models, namely synchronous, asynchronous and permanent magnet synchronous machines, with increased stability characteristics compared to traditional state-space based methods. In this work, the machine models are all derived using the state-space-nodal (SSN) theory. This results in machine models that are stable without any parasitic load or numerical snubber. This is an important improvement for these models in solver packages based on the state-space approach, such as SimPowerSystems or PLECS.

Advanced Testing Chain Supporting the Validation

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New testing and development procedures and methods are needed to address topics like power system stability, operation and control in the context of grid integration of rapidly developing smart grid technologies. In this context, individual testing of units and components has to be reconsidered and appropriate testing procedures and methods need to be described and implemented. This paper addresses these needs by proposing a holistic and enhanced testing methodology that integrates simulation/software- and hardware-based testing infrastructure. This approach presents the advantage of a testing environment, which is very close to field testing, includes the grid dynamic behavior feedback and is risks-free for the power system, for the equipment under test and for the personnel executing the tests. Furthermore, this paper gives an overview of successful implementation of the proposed testing approach within different testing infrastructure available at the premises of different research institutes in Europe.

Set-up of a Dynamic Multi-purpose Power-Hardware-in-the-Loop System for New Technologies Integration

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Future requirements on the energy system give rise to a strong increase of complexity in the electricity grid. This successively prohibits the unreflected incorporation and also testing of new equipment in the grid as well as uninformed changes to its structure. A solution to this challenge is to establish a (laboratory) environment to gain realistic and reliable insights. A viable option constitutes a Power-Hardware-in-the-Loop environment providing real-time simulation and system integration facilities. The successful set-up of a medium power level (30 kVA) Power-Hardware-in-the-Loop laboratory, which represents one of the most flexible and dynamic set-ups of its kind, is described. The requirements on components are detailed and the commissioning of the system is outlined. First results for the integration of new power hardware into the grid obtained with the system are presented.

Frequency and Voltage Support by a High-speed Flywheel Energy Storage System (FESS): A Real-time Simulation for Hardware-in-the-Loop (HIL) Testing

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A distribution network with high penetration level of renewables and Distribution Energy Resources (DER) can benefit from both high power density and high energy density Energy Storage Systems (ESS). High power density ESS can help to improve power quality measures by, for instance, voltage and frequency regulation, unbalanced load compensation, and harmonic compensation. The new-generation high-speed Flywheel Energy Storage System (FESS) with superconducting magnetic bearings has lower self-discharge rates (as low as 0.1

Graph Semi-Supervised Learning through bridgeness biased random walks

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Graph Semi-Supervised Learning (gSSL) is a classification paradigm that has received a great amount of attention due to its ability to exploit the structure of unlabeled data toghether with expert data in order to develop classifiers. Moreover, gSSL endorses an interpretation in terms of random walks propagating labeled data through the graph structure, which is the mechanism fuelling its force [1]. On the other hand, in the field of network science, a wealth of metrics was designed to mine the structure of real networks by grasping node properties and quantify their role, through measures such as centralities and, more generally, to uncover the network organization itself. The contribution of the present work sets at the crossing: indeed, we build on such network tools and incorporate them into gSSL through the design of biased random walks. This approach grants the flexibility to choose nodes and networks features we would like to inform the random walk with and, moreover, we are able to design a scalable algorithm since it is cast, by essence, as a random walk. The framework being general, we focus here on bridgeness centrality [2]. This measure aims to quantify how much a node lies on paths connecting couples of nodes within the network, discarding however contributions given by "local" paths that either start or end in the immediate neighborhood of a given node. Bridgeness can hence be leveraged for classification purposes: indeed, a source of misclassification can be the "leakage" from one class to the other, due to the links connecting the two. Therefore, we exploit it to penalize the transitions towards nodes whose bridgeness score is high: in practice, high bridgeness nodes are regarded as a proxy for the "community edge" and such penalization acts as a barrier. The efficacy of the method is then put to the test in cases, such as the one in figure, where links between the classes skew, in the classical methods like Page Rank, the classification result. Our method proves robust to those structural pitfalls, resulting in better classification performance [3]. **References**

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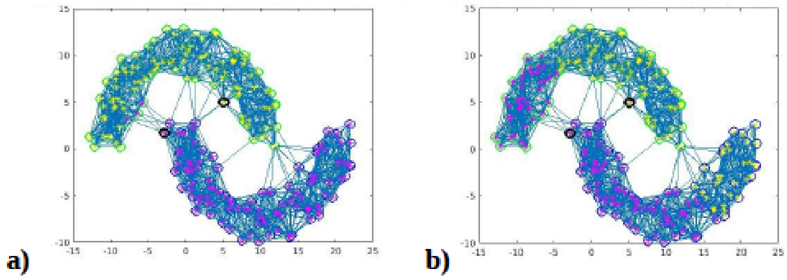

Figure 0.3: Classification result with two labels (in black) for (a) our bridgeness biased gSSL and (b) for the standard Page Rank algorithm.

On using Feynman-Sierpinski resonators to obtain high-dimensional chaos in a

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The Feynman-Sierpiński resonator [2] is a fractal circuit obtained from the Sierpiński gasket fractal [3] by realizing its branches with electrical components such as capacitors and inductors. Let us indicate with n the number of iterations of the fractal. In $n \to \infty$, the Feynman-Sierpiński resonator has singular properties, in that despite being composed exclusively of passive elements, in such limit it is dissipative [1, 2]. It is shown that for finite n, increasing n has the effect of adding poles and zeros, therefore realizing increasingly complex resonance. Here, we consider an application of the Feynman-Sierpiński resonator to chaotic circuits, and show how designing a circuit topology based on the use of such structures offers the possibility of generating high-dimensional chaos in a very simple oscillator. More specifically, we start from a single-transistor chaotic oscillator [4] and substitute the inductors in this circuit with Feynman-Sierpiński resonators of increasing order n. We show that this yields circuits exhibiting chaotic attractors with increasing fractal dimension. The number of positive Lyapunov exponents also increases, unequivocally demonstrating the effect of the Feynman-Sierpiński resonators on the dimensionality of the generated chaotic attractors. The research is carried out by means of an experimental setup realized with discrete electronic components and validating the calculation of the correlation dimension with techniques proper for the case of high dimensionality. A simplified mathematical model of the system has been derived and numerical investigations have been performed, which show results in agreement with the experimental observations.

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Torus Breakdown In A Uni Junction Memristor

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Experimental study of a uni junction transistor (UJT) has enabled to show that this electronic component has the same features as the so-called "memristor". So, we have used the memristor's direct current (DC) current-voltage characteristic for modeling the UJT's DC current-voltage characteristic. This led us to confirm on the one hand, that the UJT is a memristor and, on the other hand to propose a new four-dimensional autonomous dynamical system allowing to describe experimentally observed phenomena such as the transition from a limit cycle to torus breakdown.

On the Complexity of Robust Stability Analysis of Polytopic LTI Systems

G. Chesi

Robust stability analysis of polytopic linear timeinvariant (LTI) systems is a basic problem in engineering. This paper analyzes the complexity of three fundamental methods used to address this problem, all of them providing a sufficient and necessary condition (with finite and known sizes) for robust stability. The first method is based on the use of a polynomially parameter-dependent Lyapunov function. The second method is a simplified version of the Routh-Hurwitz stability criterion. Lastly, the third method is based on eigenvalue combinations. It is explained that the robust stability conditions provided by these three methods require to establish positive definiteness of symmetric matrix forms (SMFs) over the simplex. Also, it is explained that a sufficient condition for the latter problem can be given in terms of a linear matrix inequality (LMI) feasibility test. Hence, the complexity of the three methods is analyzed and compared by deriving the number of scalar variables in the LMI feasibility tests. A numerical example is also presented to investigate the computational time of these tests.

Metriplectic Structure of a Radiation-Matter Interaction Toy Model

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The modeling of irreversible systems is a fundamental issue in each physical field. When considering irreversibility due to dissipation, classical mechanics boasts many tools and established theories. Among them, the study of metriplectic structures unveils a simple theory based on linear algebraic tools that have immediate thermodynamical translation, not only in classical [1] but also in quantum [2] mechanics. A dynamical system defined by a metriplectic structure is a dissipative model characterized by a specific pair of tensors, which defines the Leibniz brackets. Generally, these tensors give the Poisson brackets and a symmetric metric that models purely dissipative dynamics. In literature, several examples of metriplectic systems representing irreversible dynamics can be found [3-6], but none of these models the process of the two-photon absorbtion (TPA) [7]. This work applies the metriplectic theory and Leibniz algebrae to a dissipative nonlinear optical phenomenon: the TPA by a two-level atom with negligible spontaneous emission. Such a scenario is described by the extension of the symplectic algebra of the Hamiltonian system to a metriplectic algebra of brackets [6], where the Hamiltonian component of the motion is still given by the original Poisson brackets, while a suitable semi-defined metric bracket generates the non-Hamiltonian component. An extension of the Hamiltonian, namely the free energy of the system, represents the metriplectic generator of the motion. The foregoing program interprets the dynamics of classical dissipative systems as flows generated by a new kind of Leibniz algebrae of brackets [8], namely the metriplectic bracket. In details, first we formulate the physical problem in terms of the conservative part H_0 of the total Hamiltonian H, the metric tensor G and the metriplectic brackets $\langle .,. \rangle$; then we find the mathematical expression of H as function of the dynamical variables q, p, n, with q, p the real and the imaginary part of the complex electromagnetic field amplitude, respectively, and n the population of the second level. In particular, we find the dissipative part U of H, which depends only on n. To conclude, we also find the free energy F and the equilibrium states, varying with the definition of entropy, as expected. We believe that this manuscript opens the way to explore irreversibility in nonlinear optics.

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The role of the instabilities on the quantum entanglement

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The analysis of the quantum entanglement at high temperatures has gained relevance in the last few years considering the technological applications overcoming the limitations induced by the contact with the environment. Recently, it has been shown that in systems where the dynamics of the system is unstable it becomes possible to observe entanglement even in the regime of high temperatures and that it persists for long times [1, 2]. In this work, we show that this feature is independent of the number of elements of the system, since high temperature bipartite entanglement has been found both for systems involving two subsystems as well as for three subsystems. In this communication, we present a direct relationship between quantum entanglement and associated dynamic instability. It has been verified that the instability is indispensable for generation of quantum entanglement in multipartite systems of coupled parametric oscillators.

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Frequency analysis of complex dynamics

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In 2008 the HP laboratories implemented for the firsttime in the history of electronics a memristive device [1], i.e., a device featuring dynamics belonging to the fourth passive fundamental circuit element theorized in 1971 by Prof. Chua, the memristor (memory resistor) [2]. Since then many efforts have been made to design more reliable and flexible procedures to embed memristive features into micro- and nano-scale devices. Indeed, ideal memristors can bring great improvements in many applications, ranging from neuromorphic networks to reconfigurable logic circuits, thanks to the capability of storing data defined in a continuum with no power supply. As a consequence, in the last decade there has been an increasing interest in memristive circuits. The rich dynamics a single circuit can exhibit has been the main feature stressed in literature, and, in fact, many authors have talked about "extreme multistability"[3, 4]. From the mathematical point of view, a memristor makes the state space of the system foiled, i.e., divided into a continuum of invariant manifolds, where the circuit shows as many distinct behaviors, which can be regarded to as special modifications of the same root dynamics. Such a property can be naturally explained through the Flux-Charge Analysis Method (FCAM) [5], which is a way to overcome the limitations of standard voltage-current representations by casting the circuit dynamics into the flux-charge domain, memristor's native one. As illustrated in recent work [6], a memristive circuit featuring just a single ideal memristor can be transformed via FCAM into a reduced order model with constant input. Notably, such an input depends on the initial conditions of each dynamic element, and its role is crucial, since it drives the system to different regimes, i.e., it decides the actual invariant manifold where the circuit state moves on. Thanks to this innovative perspective, the whole dynamics of a memristive circuit can be investigated through standard bifurcation analysis tools. In our previous paper [7], we have applied FCAM along with the Harmonic Balance Method (HBM) to locate the manifolds dividing the stationary regimes characterized by stable fixed points, single-loop and double-loop periodic oscillations. An illustrative example based on memristive Chua circuit showed the effectiveness of the approach, and it illustrated how such an information can be fruitfully exploited to narrow down the region where one should look for complex dynamics, such as chaos. Our recent work has been devoted to extend the combined use of FCAM and HBM to the analysis of forced memristive circuits with harmonic power supply. The application of FCAM provides again a reduced order model, this time driven by harmonic plus bias inputs, which take into account for both supply characteristic parameters and circuit initial conditions. Moreover, a generalized HBM technique to detect the onset of generic (sub-)harmonics has been developed so to locate manifolds where complex behaviors are mostly expected. In this scenario, for given frequency and phase of the power supply, the bifurcation analysis can be conveniently carried on with respect to just two parameters, one of which collects the information on the circuit initial conditions. Thanks to this approach, it is possible to show that, for significant characteristic curves of the memristors, the onset of stationary double-loop periodic solutions out of the forcing single-loop input happens on a closed curve in the two-parameter bifurcation space. Notably, the proposed bifurcation analysis can also be used to reconsider in a unique picture many of the behaviors displayed by well-known forced memristive circuits.

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A Simple Model of Coevolution for Macroscopic and Microscopic Levels

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In Thomas Schelling's famous segregation model, it is shown that the link between the individual characteristics of agents (micro) and the global states of the system (macro) is not trivial. By the use of statistical physics tools [1] it was possible, nevertheless, to establish an analytical link between these two levels, characteristics of agents (utility function) and global structures of segregation. This work aims to build a similar conceptual model, but includes an important sociological ingredient: the evolution of individual characteristics. Economic models have often been subject to criticism (by sociologists, mainly) about their arbitrary and static set of individual characteristics. In our approach we thus blend in the the standard segregation model a simple co-evolution mechanism of micro and macro levels in order to encompass, at least to some extent, the aforementioned limitation. More specifically, we add a feedback mechanism linking the agents' interactions and their individual characteristics. The most dramatic departure from the standard model regards the movement rule as we endow the agents with the possibility of wisely deciding their relocation target and, moreover, this choice is informed both by their own personal preferences and by their social ties' ones. In practice, instead of picking a different random empty cell on the lattice, unhappy agents move to the location which better suits their preferences, albeit with some noise. An adaptive decision mechanism is implemented in form of a per-agent "palatability" matrix pM_i , the size of the whole lattice, which is initialized with average values. As soon as agents appear in the model, they evaluate their location (standard Moore neighborhood) and establish links with their neighbors (proportional to their tolerance: 0 = same type only, 1 = equally split between types) on an undirected and unweighted graph. During each iteration of the model, each agent evaluates the option of either staying or leaving, given her tolerance threshold. In the latter case, the relocation target is decided mixing both the agent's personal preferences and its acquaintances: for instance, one possible strategy is to build a final decisional matrix $F(pM_i)$ from the personal matrix pM_i, and the connected agents' matrices, $pM_j(j = 1, ..., n)$, linearly weighted by a given "stubbornness" parameter $\alpha \in [0, 1]$, $F(pM_i) = \alpha pM_i + (1 - \alpha) \sum_{j=1}^{n} pM_j/n$. For the sake of simplicity, connected agents are averaged with equal weight and, in fine, the absolute best tile is taken as the destination. With this approach, we thus aim to study the co-evolution of preferences and global states in order to identify possible stationary states (at both levels): for instance,

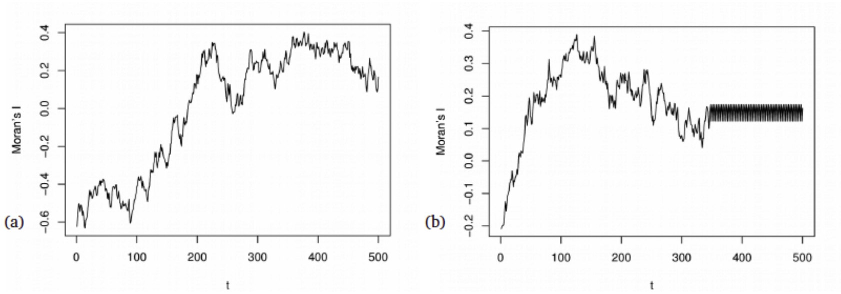

Figure 0.4: Classification result with two labels (in black) for (a) our bridgeness biased gSSL and (b) for the standard Page Rank algorithm.

preliminary results indicate that, in spite of having plugged a mechanism that we would expect to exacerbate the tendency to segretation, the system can get stuck in states where the level of segregation it is actually lower (Fig. **??**b) than the one reached without social influence (Fig.**??**a).

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Non normal amplification of stochastic quasi-cycles

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Deterministic models are customarily invoked to reproduce in silico the intertwined dynamics of large populations of microscopic actors [1]. Stationary attractors can be identified and their inherent stability assessed, via standard techniques. By tuning an apt control parameter, a stable fixed point can turn unstable via e.g. an Hopf bifurcation, the canonical route to time periodic solutions. Small-amplitude limit cycle branches from the fixed point, a dynamical transition which is intimately bound, under the deterministic paradigm, to positive (real parts of the) Jacobian eigenvalues. Stochastic perturbation can however play a role of paramount importance [2, 3]. Finite size corrections, arising from the system graininess, manifest as an endogenous source of disturbance, termed demographic noise. Under specific condition, the noisy contribution can shake the system from the inside yielding almost regular oscillations, the quasi-cycles, also when the underlying deterministic dynamics displays a stable equilibrium, hence negative defined eigenvalues of the Jacobian matrix [4, 5, 6, 7, 8]. Quasi-cycles are often modest in size, their amplitude being set by the strength of the imposed noise source. To circumvent this impediment, it is showed, in a recent work [9], that giant stochastic oscillations, with tunable frequencies, can be obtained, by replicating a minimal model for quasi-cycle amplification along a unidirectional chain. Endogenous noise fuels a coherent amplification across the array by instigating robust correlations among adjacent interacting populations. It was argued that the observed phenomenon, explained in [9] by resorting to the linear noise approximation, reflected the non normal character of the imposed interaction scheme. Non normal systems may display a short time growth for the norm of an injected perturbation, even when this latter is destined to fade away at equilibrium [10, 11, 12, 13]. The elemental ability of a non normal system to prompt an initial rise of the associated norm, stimulated by an enduring stochastic drive, could eventually secure the sought amplification process [14, 15, 16]. By considering a variant of the model presented in [9] we will inspect the dynamics of excitatory and inhibitory populations, organized in a loop (as in Figure), with varying coupling strength and degree of asymmetry [17]. It is speculated that triangular loops of the type here analyzed might define the minimal modules for self-sustained stochastic amplification in nature. By increasing the strength of the inter-nodes coupling, one moves the system towards the Hopf bifurcation and the amplitude of the stochastic oscillations are consequently magnified. When the system is instead constrained to evolve on specific manifolds, selected so as to return a constant rate of deterministic damping

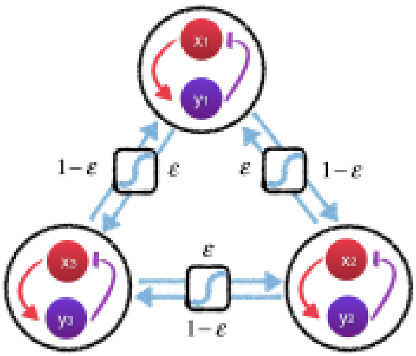

Figure 0.5:

for the perturbations, the observed amplification correlates with the degree of non normal reactivity, here quantified by the numerical abscissa. The thermodynamics of the reactive loop is also investigated and the degree of inherent reactivity shown to facilitate the out-of-equilibrium exploration of the available phase space.

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amplification of stochastic quasi-cycles (in preparation).

Friday 12th

Solving the Capacitated Vehicle Routing Problem using a Parallel Micro Genetic Algorithm

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The Capacitated Vehicle Routing Problem (CVRP) is a very extensively studied combinatorial optimization problem that aimes to determine the order in which to visit a set of customers using a homogeneous fleet of vehicles based at a single depot so that the total travel cost is minimized. In this paper, a novel coarse-grained parallel micro genetic algorithm is used for solving CVRP while the conventional migration is replaced by a synchronously seeding the overall best solution to all search processes. The computational experiments examined the behaviour of the proposed approach.

Computation of Transportation Performance in Public Service Systems

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In our contribution, we study a particular approach to test the robustness of a public service system design. We can often use scenarios where possible random failures can occur and they can influence the time accessibility of service, which is provided for system users. Construction of a suitable scenario is based on the choice of links of the transportation network, which influence the system performance in a substantial way. In such scenarios one or multiple arcs can be affected by this failure. In our contribution we present characteristics of pairs of critical arcs that can be used to develop an algorithm for the creation of critical scenarios.

Collective Effects and Performance of Algorithmic Electric Vehicle Charging Strategies

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We combine the power flow model with the proportionally fair optimization criterion to study the control of congestion within a distribution electric grid network. The form of the mathematical optimization problem is a convex second order cone that can be solved by modern non-linear interior point methods and constitutes the core of a dynamic simulation of electric vehicles (EV) joining and leaving the charging network. The preferences of EV drivers, represented by simple algorithmic strategies, are conveyed to the optimizing component by realtime adjustments to user-specific weighting parameters that are then directly incorporated into the objective function. The algorithmic strategies utilize a small number of parameters that characterize the user's budgets, expectations on the availability of vehicles and the charging process. We investigate the collective behaviour emerging from individual strategies and evaluate their performance by means of computer simulation.

Online Learning Search for Stackelberg Game

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This paper deals with the public service system design problem, in which we consider more service providers competing for the profit. We assume that the profit of a provider is proportional to transportation performance necessary to satisfy the demands of system users. The considered profit may be enlarged by system reengineering, which consists in changing current positions of some centers operated by the considered provider. Since each center relocation causes some reaction of other providers to maximize their profit, the providers' behavior can be modelled by Stackelberg's game. In this paper, we introduce an approximate solving technique for a special Stackelberg's game played by a leading service provider and other mutually cooperating providers represented by the follower. The strategy of the leading service provider may be sensitive to some parameters. To find their suitable settings, we suggest an online learning algorithm.

Secondary control may prevent Braess' paradox in AC power grids

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For a stable operation in electric networks, supply and demand have to match at all times since the grid itself cannot store any energy. To guarantee this match, different mechanisms, like day-ahead and intra-day markets are used. For unexpected mismatches, e.g. random fluctuations [1, 2], disturbances or extreme weather, fast control mechanisms are required. The control in power system is thus realized on different time scales to cope with short-term fluctuations and long-term power imbalance alike. Assuming a sudden shortage of energy or any failure in the system, the first

second of the disturbance is mainly uncontrolled, i.e. energy is drawn from the spinning reserve of the generators. Within the next seconds, the primary control sets in to stabilize the frequency and prevents a large drop. To restore the frequency back to its nominal value of 50 Hz or 60 Hz, secondary control is necessary [1]. Due to the continuous increase in demand and the high penetration of renewable energy sources, the future grid topology and control mechanisms have to adapt to cope with this increase and with spatially distributed and fluctuating renewable generation. Grid adaptation includes additional transmission lines and increasing capacity of existing lines. Contrary to expectations, not all added lines are beneficial to the stability of a grid. Indeed, adding some lines may cause the grid to lose its operating state via Braess' paradox (BP) [3] (figure **??**). Many studies investigate the effect of the fast primary control on frequency quality and power grid stability. However, secondary control is rarely considered. In this work, we propose a simple implementation of secondary control and demonstrate its effectiveness in stabilizing the power grid. We model each node by the well-known swing equation including control [1] given by:

$$\dot{\theta}_i = \omega_i \tag{0.1}$$

$$\dot{\omega}_i = -\alpha_i \omega_i - \gamma_i \theta_i + P_i - \sum_{j=1}^{n} K_{ij} \sin(\theta_i - \theta_j). \tag{0.2}$$

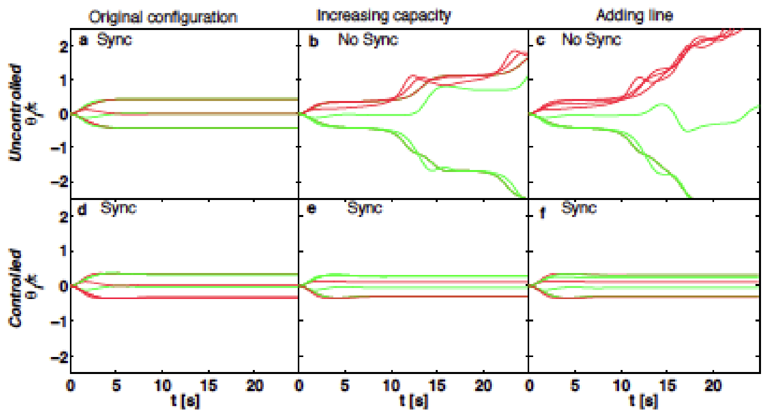

Figure 0.6: Secondary control stabilizes a network. Braess' para-dox in power grids observed when increasing the capacity of a line or adding an additional line in [3] is prevented.

Where θ_i and ω_i represent the voltage phase angle and the angular velocity deviation respectively. α_i is the damping constant, γ_i is the gain of the secondary control, P_i is the effective power fed into the grid or consumed at node i and K_{ij} determines the capacity of the line (i, j). We find that including secondary control in all nodes prevents the BP in that, increasing the capacity of a line or including a new one carries always a positive effect on the stability of the network. However when control is applied to generator nodes only, the stability depends strongly on which line capacity is increased, indicating a non trivial interaction between control and topology. **References**

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A data-driven method to dissect the dynamics of the

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In several natural and physical systems, reconstructing the graph underlying the interactions is fundamental to understand the interplay between units and the mechanisms at the base of their collective behavior. This is the case of coupled networked dynamical systems where due to several environmental and physical factors such as obstacles, sensors limited range, or components failure, the interaction network might vary in time and space. Currently, such dynamics cannot be fully captured by most existing tools nor there exists any available tools to capture these changes in real time. Here, we present a novel method to infer changes in the causal influence of units of a coupled dynamical system. The approach builds on network and information theories to propose a metric evaluating the influence as time evolves of any node on others. The method is validated on self-propelled particles where particles influence status is subject to vary over time. Our proposed method is expected to enrich the toolbox for reconstructing directed interactions in quasi-real time with few data.

A Complexity-Based Framework for Structural Health Monitoring

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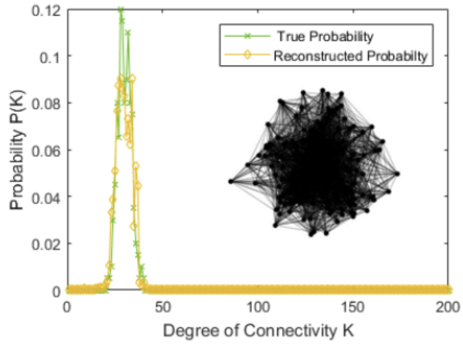
The process of implementing a damage detection strategy for aerospace, civil and mechanical engineering infrastructure is referred to as structural health monitoring (SHM). The SHM process compliments traditional nondestructive evaluation by extending these concepts to online, in situ system monitoring on a more global scale. This presentation will begin by briefly summarize the historical developments of SHM technology. Next, the current state of the art is summarized where the SHM problem is described in terms of a statistical pattern recognition paradigm. In this paradigm, the SHM process can be broken down into four parts: (1) Operational Evaluation, (2) Data Acquisition and Cleansing, (3) Feature Selection and Extraction, and (4) Statistical Model Development for Feature Discrimination. Outstanding research challenges for each portion of the paradigm will be discussed along with more global system level challenges. With this background, the discussion will them focus on consistencies and inconsistencies between the SHM community's approach to assessing damage with that done by the continuum damage mechanics community and the material science community. This comparison motivates the idea that all damage increases the complexity of a system and this complexity manifests itself at all length scales. The challenge is to determine what are the appropriate measures of complexity to be used for a given damage detection problem. Several examples of how the concept of increasing complexity can be used in the SHM context will be presented. The talk will conclude with a discussion of how the ideas of complexity can be used to generate a more principled approach to SHM that is consistent with continuum damage mechanics and material science approaches to damage assessment.



Reactive explorers to unravel network topology

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Networks are often invoked to define the skeleton for diffusing individuals, subject to local reaction rules. In many cases of interest, the architecture of the embedding network is unknown and dedicated techniques have been proposed so as to recover topological information, via suitably defined inverse protocols. A possible target is $p(k)$, the distribution of connectivities k. In this work, we discuss a viable strategy to eventually recover the sougth distribution by performing punctual measurements on just one node of the collection. A source is considered where the reactive constituents are injected, at a rate that we assume to be modulated as a stepwise function of time. Different equilibria are attained by the system, following the externally imposed modulation, and reflecting the interplay between reaction and diffusion terms. The information gathered on the observation node is used to predict the stationary density as displayed by the system, via a direct implementation of the celebrated Heterogeneous Mean Field (HMF) approximation. The entries of the sought distribution link the solution, as obtained within the HMF working ansatz, to the average density sampled on the reference node. Solving the ensuing linear problem with standard optimization tools, returns a rather accurate estimate of $p(k)$, as we shall prove for a large set of test network models. To improve on the accuracy of the reconstruction scheme one can repeat the measurements on different sites and combine together the acquired information. This significantly improve on the ability of the HMF approximation to adhere on the exact asymptotic solution, as seen in direct simulations. In our application, the reaction model is assumed of the logistic type and it is therefore tempting to ideally interpret the reactive explorers, as living entities crawling on the unknown network support.

Risk perception and epidemics in complex computer networks

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We present a self-organised method for quickly obtaining the epidemic threshold of infective processes on networks. Starting from simple percolation models, we introduce the possibility that the effective infection probability is affected by the perception of the risk of being infected, given by the fraction of infected neighbours. We then extend the model to multiplex networks considering that agents (computer) can be infected by contacts on the physical network, while the information about the infection level may come from a partially different network. Finally, we consider more complex infection processes, with nonlinear interactions among agents.

Betweenness Centrality for Networks with

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Evaluating the centrality of nodes in complex networks is one of the major research topics being explored due to its wide range of applications. Among the various measures that have been developed over the years, Betweenness centrality is one of the most popular. Indeed, it has proved to be efficient in many real-world situations. In this paper, we propose an extension of the Betweenness centrality designed for networks with nonoverlapping community structure. It is a linear combination of the so-called "local" and "global" Betweenness measures. The Local measure takes into account the influence of a node at the community level while the global measure depends only on the interactions between the communities. Depending of the community structure strength, more or less importance is given to each of these two elements. By using the Susceptible-Infected-Recovered (SIR) model in epidemic spreading simulations, we show that the "Weighted Community Betweenness" centrality is more efficient than the traditional Betweenness which is agnostic of the community structure. The proposed measure stands out also the traditional measure by its low complexity, allowing its use in very large scale networks.

Agent-based model and simulations of the

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Ports have an integral role of our economy, they are strategic places of exchange, and especially over the last few decades and with the phenomenon of globalization, the ports are a reality in continuous movement and growth. Therefore, they are operating places of extreme complexity, especially in their logistics functions of transport management. The paper deals with the modelling and implementation of the import process of goods in a port in order to make more organized, fast and efficient complex logistics network, through ad-hoc development policies. To this purpose, we develop an agent-based model (ABM) of a port, populated by the real main actors (stakeholders) involved in the port activities. The model simulates the actual port processes, i.e., the sending of goods, the acceptation or not of imported goods, the planning of transports etc. With this framework, the business process is implemented for developing a computer supported management tool to handle the port activities flow. The tool is designed for the integration in a virtual infrastructure that allows an advanced operational management of port traffics. By modelling the time documentation according to the specification of the Genoa case, the business case of the port of Genoa is tested. Results show that the mechanism implemented simulates the actual process. Moreover some bottleneck are discovered, such as delays to the handling of the containers and queues formation due to missing documentation or documentation with errors or not ready.

List of Posters

Exposing cancer's complexity using radiomics in clinical imaging

A. Barucci[1], **D. Farnesi**[1], **F. Ratto**[1], **R. Pini**[1], **R. Carpi**[2], **M. Olmastroni**[2], **M. Materassi**[3], **C. Romei**[4], **A. Taliani**[4]

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Thanks to the most advanced investigation techniques, cancer is showing to be something more complex than we ever imagined. Genomic pattern, epigenetic modifications, environmental and life-style influences leads to subjective expression of the disease. In addition, cancer can be extremely heterogeneous intrinsically, and does not stand still but changes over time. These hallmarks can explain how cancer adapts to therapies, evolving to something than can be totally different from the beginning of the disease. It's an expression of Darwin evolution.

A review on the role of water Diffusion modeling in Magnetic Resonance Imaging of Prostate cancer

A. Barucci[1], **D. Farnesi**[1], **F. Ratto**[1], **R. Pini**[1], **R. Carpi**[2], **M. Esposito**[2], **M. Olmastroni**[2], **G. Zatelli**[2]

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Prostate Cancer (PCa) is among of the tumors with highest incidence in men. Diagnosis of PCa is usually based on different techniques as digital rectal examination, prostate-specific antigen (PSA), transrectal ultrasonography, Magnetic Resonance Imaging (MRI) and transrectal biopsy. Thanks to its intrinsic ability to obtain anatomical, functional and molecular information, MRI is one of the most spread and powerful tools to diagnosis and staging of PCa. In particular, Diffusion-Weighted Imaging (DWI) MRI technique allows to obtain images with contrast depending on the microscopic mobility of water molecules in tissue, probing the microscopic structure. Moreover, from DWI images is possible to quantify the Apparent Diffusion Coefficient of water (ADC) using different diffusion models, as "Monoexponential", "Bi-exponential", "Kurtosis", "Gamma distribution" and "Stretched exponential", all of them based on different assumptions on the water mobility in the tissue microenvironment.

Logic gates implementation with coupled oscillators

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The rapid request increase for computing resources is leading to explore novel and often intriguing computing architectures. Among them, coupled oscillators have been rediscovered as a potential "beyond Moore" solution for several applications. We discuss in this work the realization of a complete set of logic gates (NOT and MAJORITY operators) as well as an inverter and a register employing coupled RLC oscillators with non-linear (cubic) resistance. The simple design allows for both analytical and numerical analysis, and it is ultimately realizable as discrete component hardware for testing purposes. It represents a simple tool to explore applications involving new computing paradigms.

Progress in modeling railway hunting behaviors by means of chaotic equations

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[2] Dipartimento Meccanica, Politecnico di Milano, Italy

This work presents some further achievements in modeling the hunting behavior of railway vehicles starting from experience in mimicking error processes in radio channels and from a recent work on hunting lateral accelerations, in which a first attempt to use similar chaotic equations has been recently proposed. Model sequences are modeled as weighted sums of chaotic functions, whose statistical features are matched to target sequences provided by experience or reliable mechanical multibody procedures. Different examples are shown, various comments are presented, and some future work is outlined.

Approximate Entropy of Spiking Series of a Neuronal Network in either Subcritical or Critical state

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Spontaneous activity of neural networks depends on their stage of development. Computational performances of a network increase when the maturation leads to a self-organized criticality. Thus, an increasing complexity in the behavior of the network is expected when it enters in this developmental stage, called critical state. We tested this hypothesis investigating with a Micro-Electrodes Array of 60 electrodes a neuronal culture that during maturation exhibited first a subcritical and then a critical state. We found that in the critical state the local complexity (measured in terms of Approximate Entropy) was larger than in subcritical conditions (mean± std, ApEn about 1.03 ± 0.10, 0.77 ± 0.18 in critical and sub-critical states, respectively; differences statistically significant), but only if the embedding dimension is at least 3 and the tolerance is fixed (we considered it equal to 1 ms, which is close to the characteristic time of neural communications).

Symmetric phase patterns in a plastic neuronal network with synaptic delay

E. L. Lameu[1,2], S. Yanchuk[3], V. L. S. Freitas[1], E. E. N. Macau[1,4], F. S. Borges[5], K. C. Iarosz[2,6], P. R. Protachevicz[7], A. M. Batista[6,7,8], J. Kurths[2,9]

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The connections between neurons in the brain have the characteristic of being modified over time due to several causes such as new experiences, injuries, brain pathologies, etc. This ability is known as synaptic plasticity and in this work we evaluate the impact of coupling changes and also synaptic delay in the dynamics of a neural network of subnetworks. We use the Hodgkin-Huxley model to describe the membrane potential of each excitatory and inhibitory neuron. Regarding the transmission of electrical signals through synapses, two different delays are considered between neurons in our model: the internal delay related to neurons in the same subnetwork and the external delay between neurons from distinct subnetworks. We verify that depending on the delays the system can reach phase synchronization in different patterns, such as global phase synchronization, anti-phase, phase-lock synchronization or even splay states. Our results show the possibility of controlling those phase configurations by means of the synaptic delays.

Symmetric circular formations with unitary speed particles

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Several living beings such as birds, fish, flies and bees perform collective motion when foraging, migrating or escaping from predators. They are able to flock to a certain direction, rotate around a common center, or swarm within an area. Biologists try to understand the local rules that lead single individuals to macroscopic group behaviors. Inspired on that, it is possible to develop models for mobile vehicles, whose applications include data collection, surveillance, monitoring, etc. Motivated by such problems, we introduce a model of particles with phase-coupled oscillators dynamics, focusing on the special case in which they rotate around a common center and are able to group into clusters. Those formations arise from an optimization procedure of certain potentials. We analyze the parameter space to find regions in which the clusters are well formed and to further understand what happens when the number of particles is not divisible by the number of clusters. We aim to find proper conditions that allows for adding or removing new particles to the system without breaking the existing formations.

Emergency Medical System Design Using Kernel Search

L. Jánošíková, P. Jankovič

Faculty of Management Science and Informatics, University of Zilina, Univerzitná 1, 010 26 Zilina, Slovak Republic

The paper deals with location of the standby sites of emergency vehicles in a large-scale area. We propose a mathematical programming model that preserves the current number of vehicles and looks for better station location. The optimization criterion is to minimize the average response time. Large problem instances are intractable in a reasonable amount of time and that is why a modification of the kernel search heuristic is proposed to get an approximate solution. A computer simulation model is used to evaluate the current and the proposed system in the Slovak Republic. The model was calibrated using real data on emergency trips.

Comprehensive Network Arc Characteristic Relative

M. Kvet, J. Janáček

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This paper deals with a way of network analysis aimed at the impact of individual arc travel time elongation on the associated service system performance. To be able to study mentioned impact, we suggest a comprehensive arc characteristic, which consists of the characteristic function and auxiliary series of affected arc sets. Based on this characteristic, the criticality of an arc can be evaluated from the point of given objective. In addition, a secondary criterion is introduced to show the size of workload transferred to other relevant network arcs. We provide a reader with a computational study performed with real road network.

Modeling Emergence of Self Organization of Knowledge in Complex Affiliation Network - An Agent-Based Approach

C. P. Sankar[1], **S. S. V. Chandra**[2], **K. S. Kumar**[3]

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[2] Computer Centre University of Kerala Trivandrum, India

In recent past has witnessed the emergence of knowledge as capital in multiple socio-economic scenarios. The underline network structure in such conditions plays the crucial role in knowledge diffusion as well as patterns of diffusion. The affiliation network is the dominant factor in the economic performance of the industry as well as of a country. For example, diffusion channel offered by the board-interlocks have already been identified as a significant facilitator of knowledge diffusion and economic performance in the competition-ridden corporate world. In this paper, we described the diffusion of knowledge as an emerging feature of complex network dynamics and introduced an Agent-Based Simulation (ABS) in an economic marketplace where systemic interactions among agents are crucial for the recombinant diffusion of knowledge through the board interlocks. In this approach, the interlocking board of directors plays a pivotal role in assessing the chances of individual firms to receive new knowledge because they act as a communication channel, enabling knowledge to be shared between boards via multiple directors who have access to inside information of multiple companies and the access to external resources and may lead into the recombinant generation of cooperation between firms. Thus board interlocks can be seen as a diffusion instrument through which knowledge has broadcasted in a network. Here, we proposed an Agent-Based Simulation model for knowledge diffusion in board interlock network. Self-organisation of knowledge has analysed as the result of systematic interactions among agents which may lead to the emergence of equilibrium knowledge level in the affiliation network. The ABM enables one to investigate effects of network structure in which knowledge interactions take place with different diffusion rate configurations for the emergence knowledge stability in the network. In particular, this may also lead to sharing of strategic and interorganisational knowledge among firms. The results of the or Simulation suggest that the diffusion of knowledge favours the emergence of creative cooperation and mutual trust between firms and hence faster rates of knowledge diffusion.

Simulation and Validation of a SpaceWire On-Board

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PLAnetary Transits and Oscillations of stars (PLATO) is a medium-class mission belonging to the European Space Agency (ESA) Cosmic Vision programme. The mission payload is composed of 26 telescopes and cameras which will observe uninterruptedly stars like our Sun in order to identify new exoplanets candidates down to the range of Earth analogues. The images from the cameras are generated by several distributed Digital Processing Units (DPUs) connected together in a SpaceWire network and producing a large quantity of data to be processed by the Instrument Control Unit. The paper presents the results of the analyses and simulations performed using the Simulator for HI-Speed Networks (SHINE) with the objective to assess the on-board data network performance.

Useful Information

Talks will be held at the **GGI – Galileo Galilei Institute for Theoretical Physics**, Largo Enrico Fermi, 2, 50125 Firenze FI, Italia. Website: www.ggi.infn.it

The **conference dinner** will be held at the Grand Hotel Baglioni, Piazza dell'Unità Italiana, 6, 50123 Firenze FI.