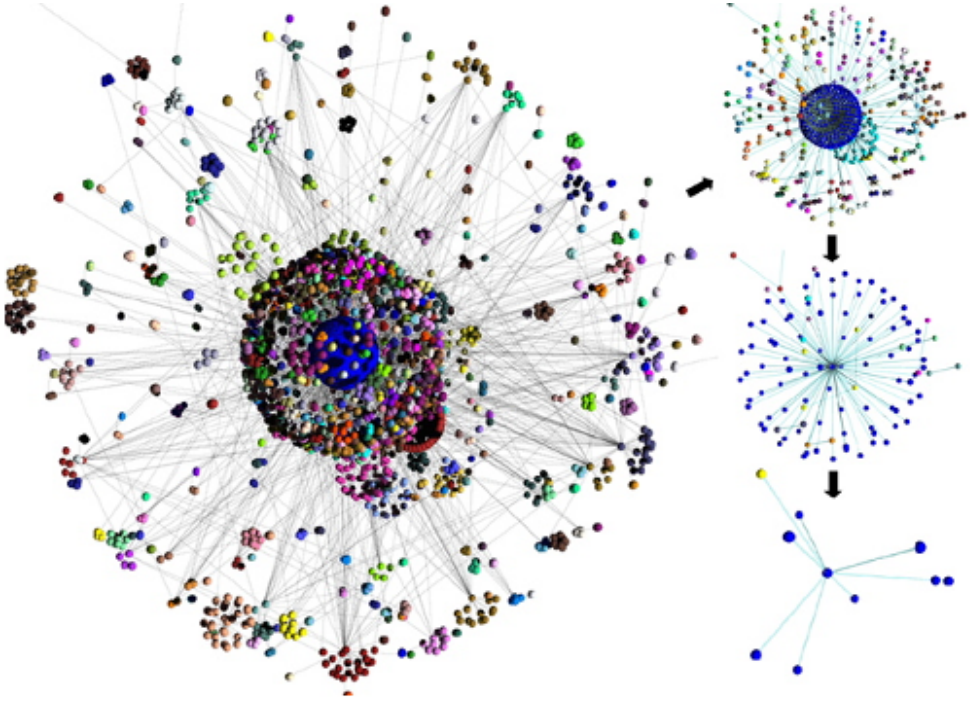

III ComplexNet

III Workshop and School on Dynamics, Transport and Control in Complex Networks - ComplexNet

São José dos Campos, 6 a 11 de outubro de 2014

INPE
MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E INOVAÇÃO
INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS

DFG Deutsche Forschungsgemeinschaft

FAPESP

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Participant Institutions

Universidade de São Paulo

Humboldt-Universität zu Berlin

Instituto Nacional de Pesquisas Espaciais

Potsdam-Institut für Klimafolgenforschung

Universidade Federal de São Paulo

Universität Potsdam

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ComplexNet - Introduction

The III ComplexNet - Workshop and School on Dynamics, Transport and Control in Complex Networks - ComplexNet - is a multidisciplinary event that aims to bring undergraduate and graduate students, postdocs and researchers interested a systemic view of the area, and covering fundamentals and applications. During the last decade, networks with complex topology have become a very powerful approach for understanding elaborate systems involving a very large number of agents that interact with each other. This approach has been used in various fields, from neuroscience and engineering, to sociology and economics. During this School, in the context of short courses, thematic lectures and panels the basic principles of complex networks will be presented as well as the methodologies that allow them to be used for the understanding of the dynamics in systems related to a broad range of areas, including lasers, interaction between neurons, Earth system complexity, autonomous mobile robots, systems energy distribution.

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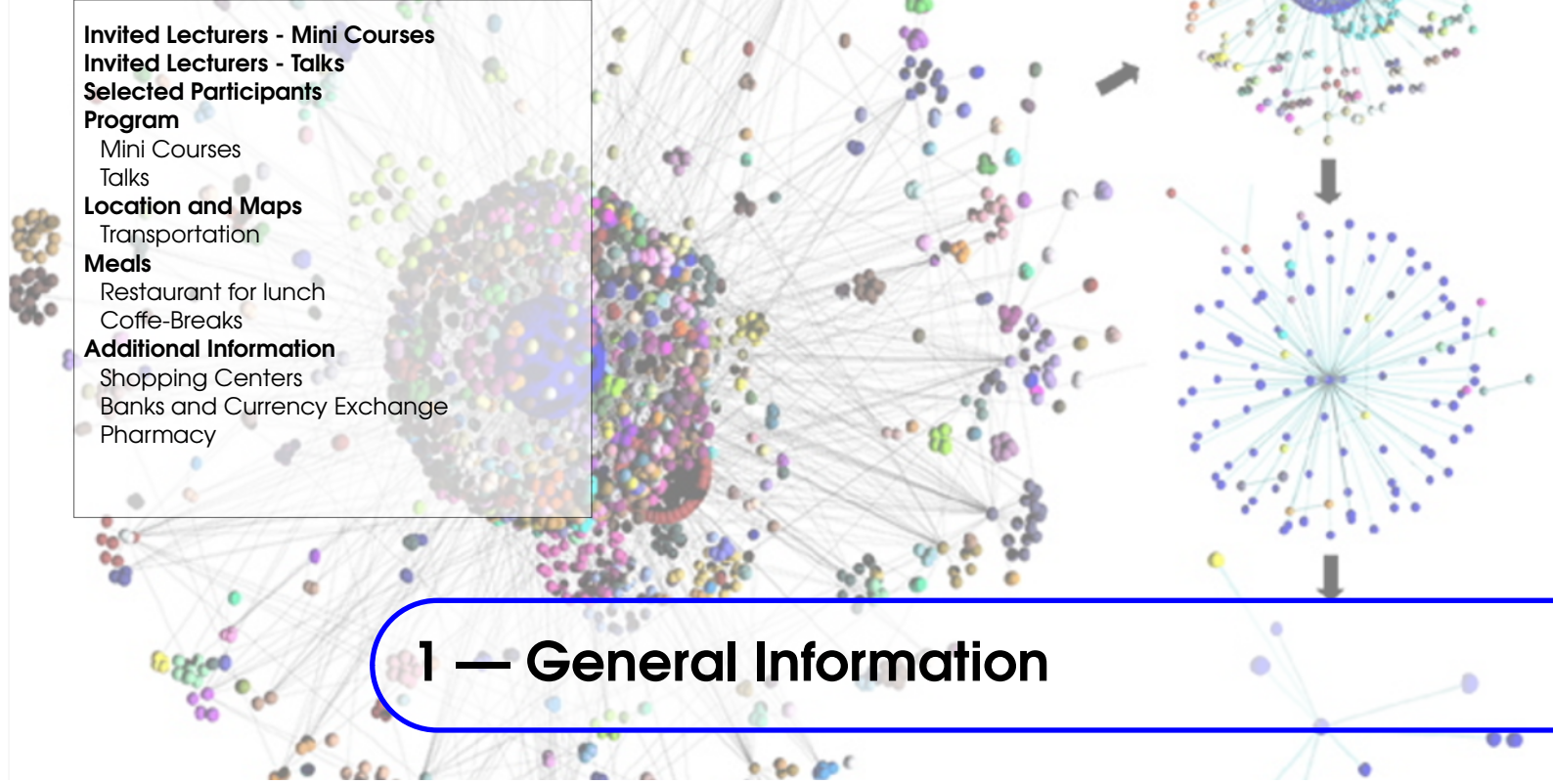


1 — General Information

1.1 Invited Lecturers - Mini Courses

M01 - Dynamics of Clustering in Networks with Repulsive Interaction

Michael Zaks
Humboldt-University

In dynamics of simple coupled systems attracting interaction usually leads to synchronization. In contrast, repulsive interaction is able to split the ensemble into clusters, to create multistability and, as we will show, in certain cases even generate continuous families of oscillatory states.

M02 - Fluctuations in models of sef-propelled particles

Lutz Schimanksy-Geier
Humboldt-University

I consider theoretical models of individual motility as well as collective dynamics and pattern formation of active particles. We focus on simple models of active dynamics with a particular emphasis on nonlinear and stochastic dynamics of such self-propelled entities in the framework of statistical mechanics. Examples of such active units in complex physico-chemical and biological systems are chemically powered nano-rods, localized patterns in reaction-diffusion system, motile cells or macroscopic animals. Based on a description of point-like active particles by stochastic differential equations,we discuss different velocity-dependent friction functions, the impact of various types of fluctuations and calculate characteristic observables such as the stationary velocity distributions or diffusion coefficients. Finally, we consider not only the free and confined individual active dynamics but also different types of interaction between active particles. The resulting collective dynamical behavior of large assemblies and aggregates of active units is discussed and an overview over some recent results on spatiotemporal pattern formation in such systems is given. Special attention is payed to the foundation of the recently discovered mesoscopic turbulence in bacterial suspension.

M03 - Networks in biology: from cell signaling to neural populations

Sten Rüdiger
Humboldt-University

Here will give an introduction into recent theoretical work on cell signaling as well as networks of neurons. First, we discuss the function of calcium in cells, which has been called a hub in signaling networks. The spatiotemporal dynamics of calcium possesses a rich variety, which enables specificity to regulate defined functions. We first present recent modeling insights for subcellular or elementary calcium signals, which require stochastic and nonlinear evolution laws. Then the excitable nature and the generation of cell wide calcium waves are discussed. In the second part of the lecture, the concepts of complex network theory will be applied to neural populations. We focus on networks in living neural cultures and introduce processes on the network, including percolation and firing dynamics, which represent dynamical properties of neurons.

M04 - Physics and Mathematics of Anomalous Diffusion

Igor Sokolov
Humboldt-University

Particle's motion in crowded environments often exhibits anomalous diffusion, whose nature depends on the situation at hand and is formalized within different physical models. Thus, such environments may contain traps, labyrinthine paths or macromolecular structures which the particles may be attached to. Physical assumptions are translated into mathematical models which often come with nice mathematical instruments for their description, e.g. fractional diffusion equations. We discuss the corresponding physical situations, their mathematical models, and the statistical tests which allow for distinguishing between cases when one or another model applies.

M05 - Regional Climate Modeling at PIK

Jan Volkholz
Potsdam Institute for Climate Impact Research

In order to investigate climate as well as climate change and its impacts, climate modeling is one of the most important tools available to researchers. In this lecture the basics of climate modeling in general are briefly touched upon. Subsequently the two basic approaches to regional climate modeling, as pursued at PIK, are presented and discussed. This includes the dynamical climate model CCLM and the statistical climate model STARS, two representatives for either school of thought.

M06 - Data based modeling: Inferring direct directed interactions from time series

Bjoern O. Schelter
University of Aberdeen

Recent years have seen a large increase in the availability of data. In fact, increasing amounts of data play a key role in every aspect of our lives, including but not restricted to physics, such as for the Large Hadron Collider (CERN) and the Square Kilometre Array (South Africa), biology, e.g. genomic data, medicine, e.g. functional magnetic resonance imaging or electroencephalography, and data mining in the social sciences or digital economies. Dealing with these data sets efficiently determines the success of the projects, treatments, assessments, and analyses. This necessity to better understand and analyze data has led to an outburst of research into advanced methods of data analysis. The inference of networks underlying complex systems is of utmost importance. Especially when dealing with complex data sets the algorithms for network inference have to fulfill certain fundamental requirements: (i) they need to deal with truly multivariate data, i.e. they must distinguish between direct and indirect influences, (ii) they have to account for various concurrent noise sources, (iii) they need to addresses both linear and non-linear systems, (iv) provide results for each sampling point, (v) and estimate the strengths of the directed interactions. Finally, (vi) they need to provide a rigorous statistical framework to allow their evaluation and (vii) be numerically efficient. A multitude of algorithms has been developed to address these extremely challenging requirements, but until now only very few can address them simultaneously. This is partly due to the fact that a rigorous mathematical framework, i.e. a theory of a suitable highly versatile class of mathematical models to comprise all of these features, is challenging. In this minicourse, the challenges will be introduced and means to address these will be discussed. Various methods will be compared and their abilities and limitations will be discussed. This results in a comprehensive overview of techniques that exists to tackle one of the key challenges of data based modeling: The detection of direct directed interactions from time series. Topics: - Spectral and cross-spectral analysis - Graphical models applying linear spectral analysis techniques as well as non-linear phase or recurrence based approaches - Granger-causality and other notions of causality - State space modeling and observational noise - Latent confounders in networks - The relation of bi- and multivariate approaches.

M07 - Introduction to Geophysical Fluid Dynamics

Cayo Prado Fernandes Francisco
Departamento de Ciência e Tecnologia Aeroespacial

Here we presente the following topics, in an integrated way: Geophysical effects in fluid flows. The Coriolis Force. Equations Governing Geophysical Flows. Geostrophic Flows. Rotation Effects. Stratification Effects. Some Considerations on Climate Dynamics.

M08 - Random Matrices: Theory and Applications

Tiago Pereira
Imperial College

I will discuss the main results in random matrices including hermitian and recent developments on non-hermitian matrices.

In particular, I will focus on the statistical behaviour of the eigenvalues and proof the universality of the eigenvalue statistics for Hermitian matrices. After this short introduction, I will discuss various applications of random matrices including data analysis and ecology.

M09 - Biochemical reaction networks: stochastic reduction under timescale separation conditions

Arthur Straube

Humboldt-University

The deterministic dynamics of biochemical reaction networks can be more easily studied if timescale separation conditions are invoked, via the quasi-steady-state assumption. In this case, the deterministic dynamics of a large network of elementary reactions are well described by the dynamics of a smaller network of effective reactions. Each of the latter represents a group of elementary reactions in the large network and has associated with it an effective macroscopic rate law. A popular method to achieve model reduction in the presence of intrinsic noise consists of using the effective macroscopic rate laws to heuristically deduce effective probabilities for the effective reactions which then enables simulation via the stochastic simulation algorithm (SSA), whose validity is a priori doubtful. We will consider a rigorously reduced linear Langevin equation description of the stochastic dynamics of monostable biochemical networks in conditions characterized by small intrinsic noise and timescale separation. The slow-scale linear noise approximation (ssLNA) can be used to calculate the intrinsic noise statistics of enzyme and gene networks. The results agree very well with SSA simulations of the non-reduced network of elementary reactions.

M10 - Reconstructing effective phase connectivity of oscillator networks from observations

Michael Rosenblum

Potsdam University

We discuss the problem of network inference from data and present an approach for invariant reconstruction of phase dynamics from observations; invariance here means independence of the recovered model on the observables used for the analysis. We start with the simplest case of two interacting oscillators and present an application of the approach to cardio-respiratory interaction in humans. We demonstrate the invariance property of our technique by showing that the coupling functions reconstructed using respiratory flow and either electrocardiogram or arterial pulse are very close. Next, we present an approach for recovery of the directional connectivity of a small oscillator network by means of the phase dynamics reconstruction from multivariate time series data. The main idea is to use a triplet analysis instead of the traditional pairwise one. Our technique reveals an effective phase connectivity which is generally not equivalent to a structural one. We demonstrate that by comparing the coupling functions from all possible triplets of oscillators, we are able to achieve in the reconstruction a good separation between existing and non-existing connections, and thus reliably reproduce the network structure.

1.2 Invited Lecturers - Talks

T01 - A flocking-like system to perform semi-supervised learning

Zhao Liang[1], Serhiy Yanchuk[1,2], Roberto Alves Gueleri[1]

[1]Departamento de Computação e Estatística, Faculdade de Filosofia, Ciências e Letras de Ribeirão Preto (FFCLRP), USP

[2]Humboldt-University

We present a nature-inspired semi-supervised learning technique based on the flocking formation of certain living species like birds and fishes. Each data item is treated as an individual in the flock. Starting from random directions, each data item moves according to its surrounding items, by getting closer to them (but not too much close) and taking the same direction of motion. Labeled items play special roles, ensuring that data from different classes will belong to different, distant flocks. Experiments on both artificial and benchmark datasets were performed and show its classification accuracy. Despite the rich behavior, we argue that this technique has a sub-quadratic asymptotic time complexity, thus being feasible to be used on large datasets. In order to achieve such performance, a space-partitioning technique is introduced. We also argue that the richness behind this dynamic, self-organizing model is quite robust and may be used to do much more than simply propagating the labels from labeled to unlabeled data. It could be used to determine class overlapping, wrong labeling, etc.

T02 - More is Less: Improving connections leads to network failure

Serhiy Yanchuk[1], Zhao Liang[2] and Jan Philipp Pade[1], Arkady Pikovsky[1]

[1]Humboldt-University
[2]Universidade de Sao Paulo / Ribeirão Preto

We study synchronisation in directed networks of differential equations with interaction akin to diffusion. In many important applications the stability of synchronised states is vital for the functioning of the network. We show that, in contrast to undirected networks, the improvement of the coupling structure, for instance the introduction of a new edge, can lead to a network failure. Furthermore, we relate this effect to topological properties of the underlying digraph.

T03 - A random laser as a dynamical network

Michael Höfner and Fritz Henneberger
Humboldt-University

The mode dynamics of a random laser in the weakly scattering regime is studied in experiment and theory. The random laser is based on a ZnO/ZnCdO multiple quantum well structure with holes as scattering centers. Time-resolved measurements reveal multi-mode spectra with individual developing features, which are qualitatively reproduced by a theoretical model. The model is expanded by applying network theory. Introducing phase-sensitive network weights provides new information on the specific self-organization of the laser field, e.g., about the connections between scatterers that are critically involved in the laser action.

T04 - Partial synchronization phenomena in networks of identical oscillators with non-linear coupling

Arkady Pikovsky[1], Elbert E. N. Macau[2], Celso Bernardo N. Freitas[2]
[1]Potsdam University
[2]Instituto Nacional de Pesquisa Espaciais - São José dos Campos

We design and study here a Kuramoto-like model, whose coupling function was tailored such that nodes with sufficiently large number of neighbors through the coupling graph may act repulsively, according to a repulsion parameter, while the remainder nodes still exhibit attraction. This model was crafted to shed more light on ensembles of non-linear oscillators with more generic coupling functions based on a local mean-field. Analytical results yield that if the repulsion parameter is small enough in comparison with the degree of the maximum hub, then the full synchronization state is locally stable. Numerical simulations are performed to explore the model beyond this threshold. We report in detail a myriad of qualitative behaviors like phase-lock, multi-stability, periodic norm of the order parameter and sensitivity dependency on initial conditions.

T05 - Detecting communities in time-varying networks

Marcos G. Quiles and João Eliakin Mota de Oliveira
Universidade Federal de São Paulo

Among several topological features that can be extracted from a network, the community structure is a very important one. There is a great effort applied to detect and analyze its community structure. Communities, or modules, can be defined as groups of nodes that are more densely connected with each other, when compared to the rest of the network. Detecting such modular structure, as well as their evolution over time, is essential to understanding the network dynamics and also the complex system it represents. Due to its importance, several community detection algorithms have been proposed albeit most of them take only static network into account. However, real-world networks are not static, but they constantly change their structure over time, thus, those community detection algorithms cannot be straightly applied to these networks. In this talk, we will revisit some issues related to the community detection problem in time-varying networks and also introduce our recent community detection models.

T06 - Synchronization of oscillators in a Kuramoto-type model with generic coupling

Michael Rosenblum[1], Elbert Macau[2], Vladimir Vlasov[1]
[1]Potsdam University
[2]Instituto Nacional de Pesquisas Espaciais

We study synchronization properties of coupled oscillators on networks that allow description in terms of global mean field coupling. These models generalize the standard Kuramoto-Sakaguchi model, allowing for different contributions of oscillators to the mean field and to different forces from the mean field on oscillators. We present the explicit solutions of self-consistency equations for the amplitude and frequency of the mean field in a parametric form, valid for noise-free and noise-driven oscillators. As an example we consider spatially spreaded oscillators, for which the coupling properties are determined by finite velocity of signal propagation.

T07 - Effect of synaptic plasticity on functional connectivity and global activity of a cortical network model

Antônio C. Roque[1], Michael Zaks[2], and Renan Shimoura [1]
[1]Department of Physics, School of Philosophy, Sciences and Letters of Ribeirão Preto, USP
[2]Humboldt-University

The cerebral cortex plays essential role in diverse brain functions. The understanding of this role involves the study of collective neural activity patterns under different situations and how these patterns relate to the structural and functional organization of the cortex. This study has recently received a new impetus with the introduction of the complex networks approach to cortical connectivity. This approach allows to relate measures of neural spiking activity to graph-theoretic measures of network connectivity. It is also known that the dynamics of cortical activity patterns depends on short and long-term synaptic plasticity phenomena. Therefore, in principle, it would be possible to relate measures of cortical spiking activity and of network connectivity to parameters controlling synaptic plasticity dynamics. The objective of this work is to study the effect of synaptic plasticity rules on the behavior of neural spiking activity patterns in a cortical network computational model. The idea is to measure changes in neural spiking patterns due to changes in the synaptic strengths among neurons and to relate these to changes in the functional connectivity of the network as disclosed by graph-theoretic measures. Our results suggest that synaptic plasticity may induce changes in the functional connectivity of the cortical network with impact on its global activity.

T08 - Phase Dynamics on Small Hexagonal Lattices with Repulsive Coupling

Michael Zaks and Petar Tomov
Humboldt-University

We consider dynamics of identical phase oscillators on small spatially periodic hexagonal lattices. Existence and stability properties of different clustering patterns are discussed and illustrated by numerical examples. In the case of the 4x4-lattice, the clustering pattern enables the existence of a constant of motion and, hence, of a continuous family of temporally periodic solutions.

T09 - The Memristor - the fourth basic passive circuit element

Paul Radtke and Arthur Straube
Humboldt-University

The 'memory resistor' or memristor is a nonlinear electric circuit element whose resistance does not remain constant but depends on the history of the system. Proposed due to symmetry considerations by L. Chua in 1971, it was not experimentally realized until 2008. Together with the resistor, the capacitor and the inductor it encompasses the basic passive circuit elements. Possible applications include the replacement of RAM (random-access memory) with nonvolatile resistive RAM. n this talk I will introduce the basic notions of the Memristor, elaborate briefly its theoretical description and an experimental realization. Further, I will show how a particular one-dimensional lattice model for a bipolar device gives rise to a Burgers equation that can be used to interpret the underlying dynamics of oxygen vacancies as nonlinear traveling waves.

T10 - Event-triggered feedback in a noise-driven phase oscillator

Justus Kromer and Lutz Schimansky-Geier
Humboldt-University

Using a stochastic nonlinear phase oscillator model, we study the effect of event-triggered feedback on the statistics of interevent intervals (IEI). Whenever the oscillator enters a new cycle, i.e., an event occurs, feedback is applied to the system by increasing (positive) or decreasing (negative) the oscillators frequency. Such models can be used to study spike-triggered currents in neurons, or feedback mechanisms in laser physics. Beside the known excitable and oscillatory regime positive feedback can lead to bistable dynamics and a change of the excitability class. Furthermore, in the excitable regime the feedback has a strong influence on noise-induced phenomena like coherence resonance or anti-coherence resonance, i.e., the minimization or maximization of IEI variability for a finite noise level. Interestingly, positive feedback increases IEI variability for a weak noise, but reduces the variability in the strong noise regime, whereas negative feedback acts in the opposite way. Therefore, both types of feedback can enhance the coherence resonance effect by additionally reducing the IEI variability, but only positive feedback can lead to anti-coherence resonance, which does not exist in the absence of feedback.

T11 - Coherent Structures on the Chaotic Transport

Iberê L. Caldas[1], Igor Sokolov[2] and Rafael Suigh[1]
[1]Instituto de Física - USP/SP
[2]Humboldt-University

In this talk, transport and mixture of particles in vortexes created by drift waves is studied using a Hamiltonian model. We find that, when two waves are considered, the transport of particles between vortexes can arise either due to jet streams or

due to chaotic trajectories. When we change the parameters, we also find some evidence suggesting that Lagrangian Coherent Structures (LCSs) are remnants of jetstreams. Finally, we study the effect of molecular diffusion (Gaussian noise) in jetstreams and Lagrangian coherent structures, finding that when the noise starts to destroy these both kinds of structures the transport of particle becomes diffusive.

T12 - A cortical multi-layered computational model and its dynamical properties

Antônio C. Roque[1], Michael Zaks[2], and Rodrigo Felipe de Oliveira Pena[1]

[1]Department of Physics, School of Philosophy, Sciences and Letters of Ribeirão Preto, USP

[2]Humboldt-University

T13 - Complex Networks: A versatile tool to analyze the spatial co-variability of extreme events in climate time series

Jürgen Kurths[1], Henrique Barbosa[2], Niklas Boers[1] and José Marengo[3]

[1]Potsdam Institute for Climate Impact Research [2]Instituto de Física da USP/SP [3]Instituto Nacional de Pesquisas Espaciais

The spatial structure of co-variability of climate time series is typically analyzed using methods based on principal component analysis (PCA). However, for applying PCA-type techniques, there exist strong restrictions concerning the distribution of the data. In particular, the behavior of extreme events cannot be captured along these lines. Here, we present a new framework to fill this gap, which is based on a non-linear synchronization measure and complex networks. Applied to rainfall in South America, this approach reveals the key features of the South American Monsoon system, allows to evaluate different datasets and climate models, but also to predict extreme rainfall and associated floods in certain situations.

T14 - Universal Double-Scale Law of Maximum Degree of Synchronization in Noisy Complex Networks

Dominik Traxl and Jürgen Kurths

Potsdam Institute for Climate Impact Research

The effects of white noise on the maximum degree of synchronization in complex networks are explored. We develop a numerical simulation framework of generic oscillator models on a broad spectrum of network topologies, coupled with both linear and non-linear coupling functions. The oscillator models include the Fitzhugh-Nagumo model, the Izhikevich model and the Kuramoto phase oscillator model. The network topologies range from regular, random and highly modular networks to scale-free and small-world networks, with both directed and undirected edges. We then study the dependency of the maximum degree of synchronization on the global coupling strength and the noise intensity. We find a universal double-scale law of the synchronizability, and quantify its validity by introducing a regression model being fit to the numerical data.

T15 - Different stages of the East Asian Monsoon in the last 9000 years

Bedartha Goswami[1], Jürgen Kurths[1] and Gilvan Sampaio[2]

[1]Potsdam Institute for Climate Impact Research

[2]Instituto Nacional de Pesquisas Espaciais

Paleoclimate records offer a wealth of information about past climatic changes. In recent years, proliferation of new paleoclimate climate datasets have allowed us to glean newer insights in to the different types of climate that existed in prehistoric times. In this study, we employ a novel approach to reconstruct the climate record of the East Asian Monsoon (EAM) from the oxygen isotopes from the publicly available dataset from Dongge Cave in Southern China, representing the proxy on an error-pree time scale and estimating the uncertainties of the proxy as well. We then derive the dynamical recurrences of the monsoon dataset from of the monsoon proxy and use it to identify different stages of the EAM in the last 9000 years. We identify three transition points at around 6400 BP, 4400 BP and 3000 BP, dividing the monsoon data into four distinct stages on monsoon intensity. The transition points occur close to well-known ice rafting events in the northern hemisphere. We also investigate the role of solar variability in these transitions and are able to show that the first and the third transitions are influenced by the short-term centennial variability of solar irradiance, whereas the second transition around 4400 BP in caused by the long-term millennial solar forcing trend.

T16 - Basin stability in complex networks and its applications

Peng Ji and Jürgen Kurths

Potsdam Institute for Climate Impact Research

By considering large perturbations, Menck et al. proposed basin stability (BS), which is a non-local and nonlinear concept and easily applicable to high-dimensional systems, based on the basin of attraction. BS is quantified as the ability to regain an

equilibrium state after being subjected to perturbations and so regarded as a stability metric of the stable equilibrium. However, an analytical study of BS is very hard because the boundary of the basin of attraction of a general nonlinear dynamical system is usually too difficult to be discerned. We start by investigating BS of a single oscillator and analytically approximate BS, and substantially investigate BS of the synchronization of a second-order Kuramoto model in complex networks. By combing a mean-field approach with a basin stability derivation, we provide a rigorous analytical treatment. The analytical results are in good agreement with the simulations.

T17 - On the importance of cascading moisture recycling in South America

Anja Rammig[1], Henrique Barbosa[2] and Delphine Zemp[1]

[1]Potsdam Institute for Climate Impact Research

[2]Instituto de Física da USP/SP

Continental moisture recycling is a crucial process of the South American climate system. Evapotranspiration from the Amazon basin contributes to precipitation regionally and in the La Plata basin. Here we present an 5 in-depth analysis of South American moisture recycling. We quantify the importance of "cascading moisture recycling", which describes the exchange of moisture between the vegetation and the atmosphere through precipitation and re-evaporation cycles on its way between two locations on 10 the continent. We use the Water Accounting Model 2-layers (WAM-2layers) forced by precipitation from TRMM and evapotranspiration from MODIS for the period 2001 until 2010 to construct moisture recycling networks. These networks describe the direction and amount of moisture trans15 ported from its source (evapotranspiration) to its destination (precipitation) in South America. Model-based calculations of continental and regional recycling ratios in the Amazon basin compare well with other existing studies using different datasets and methodologies. Our results show that cas20 cading moisture recycling contributes about 10% to the total precipitation over South America and 17% over the La Plata basin. Considering cascading moisture-recycling increases the total dependency of the La Plata basin on moisture from the Amazon basin by about 25% from 23% to 29% during 25 the wet season. Using tools from complex network analysis, we revealed the importance of the south-western part of the Amazon basin as a key intermediary region for continental moisture transport in South America during the wet season. Our results suggest that land use change in this region might 30 have a stronger impact on downwind rainfed agriculture and ecosystem stability as previously thought.

T18 - Regional climate modeling over South America with COSMO-CLM: tuning, evaluation, application.

Jan Volkholz[1], José Marengo[2] and Stefan Lange[2]

[1]Potsdam Institute for Climate Impact Research

[2]Instituto Nacional de Pesquisas Espaciais

In the first part of the talk I present tuning results for the regional climate model COSMO-CLM over South America with a focus on model sensitivities to the parameterizations of convection and non-precipitating subgrid-scale clouds. In the second part I outline a novel complex networks approach to climate model evaluation. Required measures of difference between networks are discussed and results of a proof of concept study are presented. Thirdly, I will give an introduction to my latest project of a reconstruction of the climate of the central Andes with COSMO-CLM. The project aims at closing gaps in meteorological observations with the ultimate goal of quantifying the contributions of the various factors contributing to the retreat of tropical Andean glaciers.

T19 - Multiple relationships between fire and land-use types in the Brazilian Amazon-rethinking the fire-deforestation paradigm

Kirsten Thonicke[1], Manoel Cardoso[2], Ana Cano Crespo[1]

[1]Potsdam Institute for Climate Impact Research

[2]Instituto Nacional de Pesquisas Espaciais

Anthropogenic activities alter the spatial extent of wildfires. Land conversions outweigh climatic drivers of wildfire burned area in South America. In the Amazon, fire is widely used for the initial conversion of extensive areas of natural vegetation into agricultural fields and pasture areas, and for the subsequent maintenance of deforested areas. Natural fire occurrences are extremely rare, with the vast majority of burning events resulting from deliberate fire use. So how does fire occurrence and extent relate to land-use type in the Brazilian Amazon? Our study area comprised the states of Mato Grosso, Pará and Rondônia. Temporal and spatial distribution of rainfall and burned area was analysed in 2008 and 2010, and processes taking place in the forest that can induce burning incidents were also examined. Predictably, the peak of burned area coincided with the months of

lowest rainfall at the end of the dry season (August-September), showing a marked annual periodicity. In 2010, the fire season was longer and a larger amount of burned area was detected, as a consequence of the drought that struck the Amazon basin in that year. However, the satellite-derived standardized anomalies for dry-season rainfall showed that there were spatial disparities in the influence of the 2010's extreme drought. Moreover, we observed that the areas with the largest rainfall anomaly did not match the burned area distribution, which is a sign of fire connection to anthropogenic factors in the study area. The proportion of burned area in the different land-use types was examined, indicating large variation depending on the state under evaluation. We found that the largest proportion of burning was not happening in deforested areas, but in pasture and forest or secondary vegetation (excluding savannah-like ecosystems). While land-use distribution in the states remained similar in 2010, significant differences were noted in the burned area location, compared to 2008's figures. As we know, fire is used for land clearing and management in agriculture and pasture lands, but in order to understand why fires occur into the forest we monitored the evolution of deforested, logged and degraded areas over time. Lagged effects of those areas on burning episodes were quantified. The inclusion of land-use change effects on fire activity into models that simulate burning events will allow us to project the environmental impact of land-conversion in the Amazon.

T20 - Disentangling Sources of Anomalous Diffusion

Domingos H. U. Marchetti[1], Igor Sokolov[2] and Felix Thiel[2]

[1]Instituto de Física da USP

[2]Humboldt-University

One of the most often measured quantities in diffusion experiments is the mean squared displacement (MSD). A non-linear, power-law like time dependence is the trademark of anomalous diffusion. Although anomalous diffusion is often observed it is not obvious what causes this behaviour. We propose two physical categories of sources for anomalous diffusion and show how they can be separated by means of a simple moment analysis of the process. The strength of our method lies in the fact, that it is even applicable when the anomalous behaviour has multiple origins and is able to separate them.

T21 - Explosive synchronization in complex networks

Francisco Aparecido Rodrigues[1], Jürgen Kurths[2] , Thomas Peron[1]

[1]Instituto de Física de São Carlos - USP

[2]Humbold University and Potsdam Institute for Climate Impact Research

Synchronization is a ubiquitous phenomenon in both the natural world and in technology. Kuramoto oscillators display a second-order phase transition to the synchronous state with a critical coupling strength that depends on the network topology. Recently, it has been observed that a first-order synchronization transition can be observed in complex networks when there is a positive correlation between the heterogeneity of the connections and the natural frequencies of the oscillators. This phenomenon is called explosive synchronization. In this presentation, we consider mean-field approximations to determine the critical coupling of explosive synchronization in complex networks. We demonstrate that the equation obtained for the critical coupling has an inverse dependence on the network average degree. Moreover, we show that the inclusion of time-delay enhances the level of synchronization. Finally, we demonstrate that the nodes in a second-order Kuramoto model perform a cascade of transitions toward a synchronous macroscopic state. Our findings are in good agreement with numerical simulations and fundamentally deepen the understanding of microscopic mechanisms toward synchronization.

T22 - Explosive synchronization: Influence of the frequency in the discontinuous phase transition

Francisco Rodrigues and Edmilson Roque dos Santos

Instituto de Ciências Matemáticas e de Computação - USP/São Carlos

Synchronization is pervasive in nature, society and technology. This collective behavior emerges from the interaction of neurons in the central nervous system, power grids, crickets, heart cells and lasers. Synchronization arises due to the adjustment of rhythms of self-sustained periodic oscillators weakly connected. Recently, it has been observed discontinuous phase transition in synchronization processes, called explosive synchronization. This phenomenon emerges when the natural frequency of each oscillator is correlated with its degree. In this presentation, we will show the results obtained when only a percentage of oscillators have the natural frequencies positively correlated with their degrees. In addition, we have analyzed the influence of the most connected vertices, hubs, on the emergence of explosive synchronization.

T23 - From molecular motors to neural spiking - complex systems in biology

Benjamin Lindner

Humboldt-Universität

In my talk I review some theoretical approaches to capture the statistics of complex biological systems. Specifically, I will discuss the transport properties of groups of coupled molecular motors and the firing statistics of nerve cells in the recurrent networks of the brain

T24 - A Model for Slow Axonal Transport: cargo - motor interaction

Carla Goldman
IF USP - São Paulo

If we look at the transport in neuronal axons, two types prevail: the fast transport of vesicular cargoes, which reaches average transport velocities of around 1-5m/s, and the much slower transport of cytosolic cargoes. The latter are categorized into two sorts, cytosolic protein complexes (slow component b), transported at speeds of 0.02-0.09m/s and neurofilaments (slow component a), transported at speeds around 0.0002-0.01m/s . These values represent the overall transport rate, found by radiolabeling, the instantaneous transport speeds for slow component a and b, as measured by light microscopy, are of the same order of magnitude as for vesicular cargoes. While the transport mechanisms for vesicular cargoes have long been attributed to the action of molecular motors, the transport of cytosolic cargoes remains elusive. We shall examine the possibility that the same mechanism of transport via molecular motors can also explain the slow transport. Our theoretical formulation is based on a ASEP dynamics (asymmetric simple exclusion process) complemented by a Langmuir dynamics to allow cargo attachment and detachment from the motors.

T25 - Influence of strong electrical coupling on bursting neurons

Reynaldo D. Pinto[1], L. Schimansky-Geier[2], Justus A. Kromer[2], Boris Marin[1]
[1]Instituto de Física de São Carlos, USP/ São Carlos
[2]Hubmoldt University

Electrical coupling has a strong influence on collective neural activity and on individual neurons behavior. Motivated by the impact of electrical coupling on neurons in a biological central pattern generator (CPG), we study the influence of such coupling on the activity of slow-wavebursters. Using a Morris Lecar model neuron we show that electrical coupling acts like an additional independent current. Performing a bifurcation analysis, we showed that strong electrical coupling changes the neuron type of bursting and excitability. Our model describes well the behavior of the stomatogastric ganglion CPG pacemaker neurons and give rise to a dynamical approach on understand the role of strong electrical coupling in biological neural networks.

T26 - Degree correlations optimize neuronal network sensitivity to sub-threshold stimuli

Sten Rüdiger[1], Alexandre Hiroaki Kihara[2], Christian Schmeltzer[1]
[1] Humboldt-University
[2]Universidade Federal do ABC

Information processing in the brain crucially depends on the topology of the neuronal network. We investigate how this topology influences the response of a population of integrate-and-fire neurons to a stimulus. We provide a method to calculate firing rates from a self-consistent system of equations taking into account the degree distribution and degree correlations in the network. We show that assortative degree correlations strongly improve the sensitivity for weak stimuli and propose that such networks possess an advantage in signal processing. We moreover find that there exists an optimum in assortativity leading to a maximum in input/output mutual information.

T27 - Functional regulation of nitric oxide in the adaptation of retinal newtorks

Sten Rüdiger[1], Alexandre Hiroaki Kihara[2], Christian Schmeltzer[1]
[1] Humboldt-University
[2]Universidade Federal do ABC

In the nervous system within physiological conditions, nitric oxide (NO) production depends on the activity of nitric oxide synthases (NOSs), and particularly on the expression of the neuronal isoform (nNOS). In the sensory systems, the role of NO is poorly understood. In this study, we identified nNOS-positive cells in the inner nuclear layer (INL) of the rat retina, with distinct characteristics such as somata size, immunolabeling level and location. Employing mathematical cluster analysis, we determined that nNOS amacrine cells are formed by two distinct populations. We next investigated the molecular identity of these cells, which did not show colocalization with calbindin (CB), choline acetyltransferase (ChAT), parvalbumin (PV) or protein kinase C (PKC), and only partial colocalization with calretinin (CR), revealing the accumulation of nNOS in specific amacrine cell populations. To access the functional, circuitry-related roles of these cells, we performed experiments after adaptation to different ambient

light conditions. After 24h of dark-adaptation, we detected a subtle, yet statistically significant decrease in nNOS transcript levels, which returned to steady-state levels after 24h of normal light-dark cycle, revealing that nNOS expression is governed by ambient light conditions. Employing electron paramagnetic resonance (EPR), we demonstrated that dark-adaptation decreases NO production in the retina. Furthermore, nNOS accumulation changed in the dark-adapted retinas, with a general reduction in the inner plexiform layer. Finally, computational analysis based on clustering techniques revealed that dark-adaptation differently affected both types of nNOS-positive amacrine cells. Taken together, our data disclosed functional regulation of nNOS expression and activity, disclosing new circuitry-related roles of nNOS-positive cells. More importantly, this study indicated unsuspected roles for NO in the sensory systems, particularly related to adaptation to ambient demands.

T28 - Decomposition of stochastic flows with jumps in manifolds with complementary foliation

Paulo Ruffino and Leandro Morgado
UNICAMP

Letbe a differentiable manifold endowed locally with two complementary foliations (e.g. a coordinate system), say horizontal and vertical. That is: in a neighbourhood of each pointin M there are two submanifolds passing through, with complementary dimensions. We consider two subgroups of (local) diffeomorphisms ofgenerated by vector fields tangent to each foliation. Let be a stochastic flow of diffeomorphisms ingenerated by a semimartingale with jumps (the so called Marcus equation). We prove that in a neighbourhood of an initial condition, up to a stopping time one can factorize: where the first component is again a solution of a Marcus equation (autonomous vector fields) in the group of horizontal diffeomorphisms and the second component is a process in the group of vertical diffeomorphisms. Further decompositions, considering more than two foliations include more than two components: it leads to a maximal cascade decomposition in local coordinates where each component acts only in the corresponding coordinate.

T29 - Exponential growth rates and stability of Lévy systems: Furstenberg-Khasminskii-type formulas

Jan Gairing[1], Peter Imkeller[1]
[1]Humboldt-University

Exponential growth rates of (linear) systems are usually referred to as Lyapunov exponents. In the case of a linear Stratonovich SDE driven by an m-dimensional Brownian motion the celebrated Furstenberg-Khasminskii formula relates the "time average" that describe the Lyapunov exponents to a "space average" over the unit sphere with respect to the ergodic measure of the dynamics of the projection.We derive a Furstenberg Khasminskii-type formula in a linear Markovian context.It has been observed that the smaller exponents are not adapted and we further investigate the dynamic of the projection to the corresponding eigenspaces via anticipative methods. The main object of study are linear SDE driven by a Lévy process. Solutions are discontinuous semimartingales generalizing the Brownian SDE to jump process. We will consider the special case of the linear "Marcus" equation, which has the advantage that its solutions can be defined on manifolds and that it satisfies the Leibniz rule. We interpret the solutions as the linearization of a in general non-linear flow diffeomorphisms, generated by Marcus equations similar to the Brownian case. In particular stability properties with respect to initial conditions can be addressed via the method.

T30 - First Exit Times for Levy driven Diffusions with Exponentially Light Jumps in R^d

André de Oliveira Gomes and Michael Högele
Potsdam University

We will discuss the problem of the first exit times for the trajectories of the solutions for these type of diffusions from a bounded domain in R^d and examine the law and mean value of the first exit time in the regime of small noise limit.

T31 - Transport equations driven by Hölder paths via characteristics

Pedro José Catuogno and Rafael Andretto Castrequin
UNICAMP

We present a class of Transport Equations driven by non-differentiable paths (Hölder type regularity). This is important to study system of differential equations under noise. The main example of Hölder type of noises are fractional Brownian motion with Hurst parameter greater than one half. We will use the method of characteristics to represent the solution through ODE solutions (also driven by the same Hölder path).

T32 - Regional differences of aridity/drought conditions change over Northeast Brazil:

Present and future projections

José A. Marengo

Instituto Nacional de Pesquisas Espaciais - Cachoeira Paulista

The focus of this study is to investigate the risk of aridification in the semiarid lands of Northeast Brazil, using a variety of observational information and climate change projections for the future, by means of aridity indices. We use the Budyko and United Nations aridity índices to assess the extension of areas with semi arid and arid conditions in the present, and for the future until 2100. Climate projections come from the downscaling of HadCM3 model for the A1B scenario using the Eta regional model with horizontal resolution of 40 km. Regional climate change projections suggest the increase in dryness in the region, with rainfall reductions, temperature increases and water deficits and longer dry spells, leading to drought and arid conditions, to prevail by the second half of the 21th century. The area with arid conditions is projected to grow to cover areas currently with dry sub humid conditions, and becoming larger by 2100. This increase in aridity, combined with land degradation may increase the risk of desertification.

T33 - Complex networks to represent and characterize climate

Guillermo Obregon

Instituto nacional de Pesquisas Espaciais - Cachoeira Paulista

The rainfall variability characteristics observed at regional scales are a response of the complex non-linear and non-local physical and dynamical processes between the different components of the climate system, which have their own temporal characteristics. The Amazon climate is a subject of continuous interest because their potential impact in regulating the climate on both regional and global scale, but the main problem in study the rainfall variability over Amazonia is related with its continental characteristic, which can result in biased analyses for rainfall variability over Amazon Basin. Therefore the present study is motivated by two scientific issues. One pertains to the rainfall spatial regionalization, based on gridded daily rainfall observed data for the period of 1979 to 1993, and other to study the time-scales variability of indices representative of each region. The results show n that the rainfall over Amazon Basin can be clustered in six spatial homogeneous regions with peculiar characteristics, among others: annual cycle, daily probability distribution of frequency, intraseasonal variability and related to determinate domain of large scale circulation. The next step is try to find large scale patterns, associated to each one of the rainfall regions, applying the idea of the structure and dynamics of complex networks to the large scale circulation.

T34 - Modeling microphysics effects in cloud life cycle of clouds in the Amazon

Henrique Barbosa

Instituto de Física - USP

The effects of aerosol particles on cloud microphysical properties, cloud cover, precipitation, and regional climate are significant. The Amazon region is particularly susceptible to changes in number-diameter distributions n(d) of the atmospheric particle population because of the low background concentrations and high water vapor levels, indicating a regime of cloud properties that is highly sensitive to aerosol microphysics. Present and future anthropogenic activities can significantly alter the number-diameter distribution that prevails under natural conditions. At present time, the prevailing distribution n(d) undergoes rapid transient changes between wet season and dry season as well as when affected by biomass burning. There are also possible secular trends in n(d) related to economic development. The climatic implications are profound,2-5 ranging from modulation of local precipitation intensity to modifying large-scale circulations and energy transport associated with deep convective regimes6 Any changes in tropical precipitation can have significant, potentially global consequences because of non-linear multiscale interactions of tropical waves with precipitation in the Amazon, leading also to possible changes in the Atlantic intertropical convergence zone (ITCZ).

T35 - Statistical Analysis of extreme events in long-time series from Amazon basin

Lincoln Muniz Alves

Instituto nacional de Pesquisas Espaciais - Cachoeira Paulista

A number of extreme climate events, such as severe droughts and floods, in the Amazon basin occurred in recent years. These events caused significant consequences for the ecosystems and for regional people. One of the most important questions regarding short term extreme events is whether their occurrence is increasing or decreasing over time. As a starting point for this, here we used rainfall dataset, during the period 1961-2010 in order to investigate possible trends in annual and seasonal precipitation. The Mann-Kendal test is performed to investigate the trends. In addition, a large ensemble of simulations with the global and regional models are used to assess the potential impact of climate change on precipitation over Amazon basin and explore the uncertainties associated with the various model parameterizations.

T36 - Real Time Vision

Roland Köberle
Instituto de Física de São Carlos, USP

Reconstructing a 3-dimensional scenery from the 2-dimensional information available at the retina is an ill-posed problem. It does not have a unique solution. To complicate matters, this 2-dimensional information has to be compressed into a sequence of action potentials for neural processing. On top of all this, sensory systems have to accomplish this reconstruction task in real time, i.e., fractions of seconds. How can it be done at all? It has been suggested that this process occurs in several stages: the visual system extracts first the most important features and additional details are filled in later on. Here we show that in this first stage nearly all the information acquired by the visual system is used up to encode these most important features into sequences of action potentials. We also show that these features can be recovered from the spike trains in real time. We also point out the difficulties correlation function based methods encounter to accomplish this task.

1.3 Selected Participants

Aline Pereira da Silva Instituto Nacional de Pesquisas Espaciais *Propagation of information and cultures in complex networks*
Ana Cano Potsdam Institute for Climate Impact Research *Multiple relationships between fire and land-use types in the Brazilian Amazon-rethinking the fire-deforestation paradigm*
André Gomes Potsdam University *First Exit Times for Levy driven Diffusions with Exponentially Light Jumps in R^d*
Andreia Nalu Soares Hisi sem vinculos *The phase transition of a SIRS infectious disease model*
Antonio Marcos Batista UEPG *Basin attraction in a chaotic transport model*
Antônio Mário de Torres Ramos INPE *Causality Network Between Different Climate Systems.*
Barbara Maximino da Fonseca Reis Instituto Nacional de Pesquisas Espaciais *TBD*
Bedartha Goswami Potsdam Institute for Climate Impact Research *Different stages of the East Asian Monsoon in the last 9000 years*
Bethiele Milagre Leite Universidade Regional do cariri- URCA *Complex network analysis of college students*
Cândida da Silva Ferreira Barreto UFBA *Functional Brain Networks of Individuals with TDAH*
Celso Bernardo Nóbrega Freitas Inpe *Synchronization effects related to neighborhood similarity*
Christian Schmeltzer Humboldt-University *Degree correlations optimize neuronal network sensitivity to sub-threshold stimuli*
Delphine Zemp Potsdam Institute for Climate Impact Research *On the importance of cascading moisture recycling in South America*
Dominik Traxl Potsdam Institute for Climate Impact Research *Universal Double-Scale Law of Maximum Degree of Synchronization in Noisy Complex Networks*
Edmilson Roque dos Santos Universidade de São Paulo *Explosive synchronization: Influence of the frequency in the discontinuous phase transition*
Faimison Rodrigues Porto Universidade de São Paulo *A Systematic Mapping of Software Systems as Complex Networks*
Felix Thiel Humboldt-University *Disentangling Sources of Anomalous Diffusion*
Filipe Alves Neto Verri Universidade de São Paulo *Label distribution analysis via Bayesian dynamical process*
Jan Gairing Humboldt-University *Exponential growth rates and stability of Lévy systems: Furstenberg-Khasminskii-type formulas*
Jan Philipp Pade Humboldt-University *More is Less: Improving connections leads to network failure*
João Eliakin Mota de Oliveira Unifesp *Community Detection with Coupled Kuramoto Oscillators*

OBS: *All the selected participants will be asked to to a short presentation (5 + 3 min) about their accepted work during the Poster Section.*

José Mario Vicensi Grzybowski UFFS *TBD*
Justus Kromer Humboldt-University *Event-triggered feedback in a noise-driven phase oscillator*
Kelly Cristiane Iarosz Universidade de São Paulo *Synchronization and plasticity in coupled circuits*
LEONARDO BACELAR LIMA SANTOS Cemaden *Urban mobility complex network on a geographical approach*
Lucas Campanari Simplicio dos Santos Universidade de São Paulo *Control and Synchronization of Linearly Coupled Neurons*
Luiz Felipe Ramos Turci UNIFAL-MG *Adaptive Pinning of Mobile Agent Network*
Marcelo Serrano Zanetti UFMA *Categorizing bugs with social networks: a case study on four open source software communities*
Marcos Daniel Nogueira Maia INPE *Community detection in complex networks via dynamics*
Maria Daniela leite de Souza, URCA-Universidade Regional do Cariri *Applications of the ising model on complex networks*
Michael Höfner Potsdam University *First Exit Times for Levy driven Diffusions with Exponentially Light Jumps in* R^d
Niklas Boers Potsdam Institute for Climate Impact Research *Complex Networks: A versatile tool to analyze the spatial co-variability of extreme events in climate time series*
Oiram Santos Jr ITA *TBD*
Paul Radtke Humboldt-University *The Memristor - the fourth basic passive circuit element*
Paulo Eduardo Pinto Burke UNIFESP *TBD*
Paulo Roberto Urio Instituto de Ciências Matemáticas e de Computação *DNAYA - A fast agent-based model prototyping framework tool*
Pedro Henrique Maia dos Santos ETEP Faculdades *Nonlinear Oscillators and Interactions*
Pedro Teodoro Cardoso Canário Universidade Federal da Bahia *The time evolving networks of the cortical dynamics*
Peng Ji Potsdam Institute for Climate Impact Research *Basin stability in complex networks and its applications*
Petar Tomov Humboldt-University *Phase Dynamics on Small Hexagonal Lattices with Repulsive Coupling*
Rafael Suigh Institute of Physics, USP - São Paulo *Coherent Structures on the Chaotic Transport*
Renan Shimoura Department of Physics, USP - Ribeirão Preto *Effect of synaptic plasticity on functional connectivity and global activity of a cortical network model*

OBS: *All the selected participants will be asked to to a short presentation (5 + 3 min) about their accepted work during the Poster Section.*

Roberto Alves Gueleri Department of Computation, USP - Ribeirão Preto *A flocking-like system to perform semi-supervised learning*
Rodolfo Maduro Almeida Universidade Federal do Oeste do Pará *A model for vegetation fire dynamics in a Brazilian Cerrado Ecological Reserve*
Rodrigo Felipe de Oliveira Pena Department of Physics, USP - Ribeirão Preto *A cortical multi-layered computational model and its dynamical properties*
Stefan Lange Instituto Nacional de Pesquisas Espaciais *Regional climate modeling over South America with COSMO-CLM: tuning, evaluation, application.*
Thomas Kaue Dal Maso Peron USP *TBD*
Vander Luis de Souza Freitas INPE *Data mining applied to the Netlogo flocking model*
Vladimir Vlasov Potsdam University *Synchronization of oscillators in a Kuramoto-type model with generic coupling*

OBS: *All the selected participants will be asked to to a short presentation (5 + 3 min) about their accepted work during the Poster Section.*

1.4 Program

1.4.1 Mini Courses

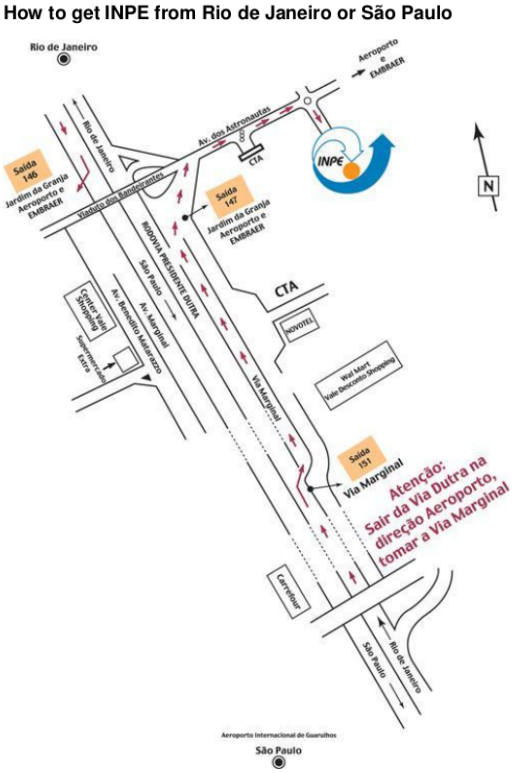
Time	Monday 06/10	Tuesday 07/10	Wednesday 08/10
8:15-8:30	Open-1		
08:30-10:00	M07	M07	M05
10:00-10:20	Coffe-Break	Coffee-Break	Coffee-Break
10:20-11:50	M06	M09	M06
11:50-12:20	M01	M03	M09
12:20-14:00	Lunch	Lunch	Lunch
14:00-15:30	M04	M04	M02
15:30-16:00	M01	M01	M03
16:00-16:20	Coffee-Break	Coffee-Break	Coffee-Break
16:20-17:50	M08	M10	M08

1.4.2 Talks

Time	Thursday 09/10	Friday 10/10	Saturday 11/10
08:15-08:30	Open-2		
08:30-08:55	T01	T17	T32
08:55-09:20	T02	T18	T33
09:20-09:45	T03	T19	T34
09:45-10:10	T04	T20	Discussions
10:10-10:30	Coffe-Break	Coffe-Break	Coffe-Break
10:30-10:55	T05	T21	Poster / Short Presentations
10:55-11:20	T06	T22	Poster / Short Presentations
11:20-11:45	T07	T23	Poster / Short Presentations
11:45-12:10	T08	T24	Closing
12:10-14:00	Lunch	Lunch	Lunch
14:00-14:25	T09	Discussions	T35
14:25-14:50	T10	T25	T36
14:50-15:15	T11	T26	
15:15-15:40	T12	T27	
15:40-16:00	Coffe-Break	Coffe-Break	
16:00-16:25	T13	T28	
16:25-16:50	T14	T29	
16:50-17:25	T15	T30	
17:25-17:50	T16	T31	

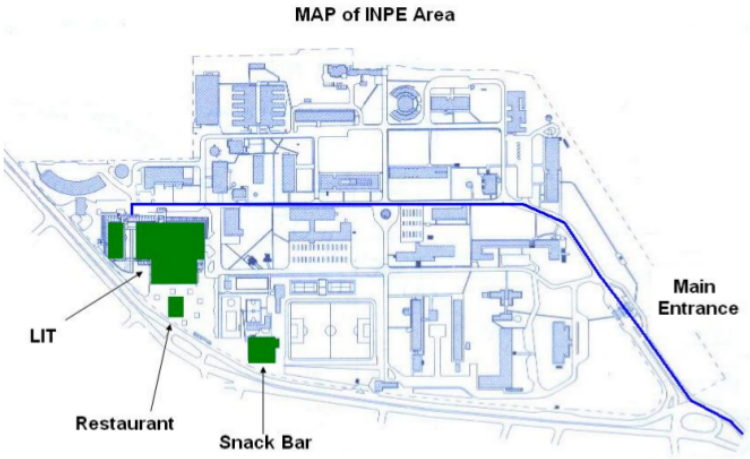
1.5 Location and Maps

The school will be held at the *Instituto Nacional de Pesquisas Espaciais* (INPE) National Institute for Space Research.

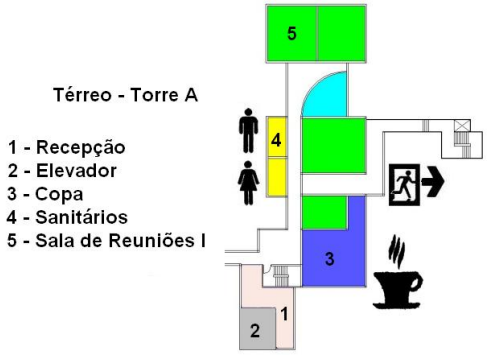


Enter in INPE:

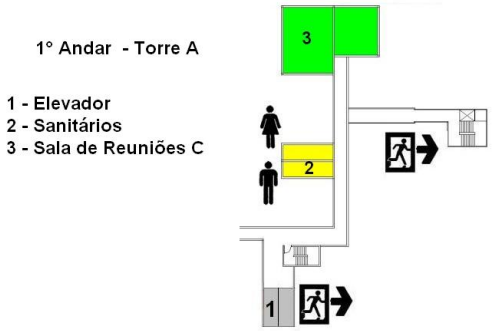
Arriving at the main gate of INPE you must identify yourself as Participant ComplexNet and check your name on the list. Please carry ID or equivalent document. The registration start at 07:30 in the LIT building. The opening of the School will be 8:15.



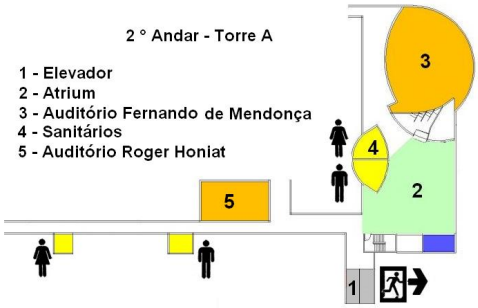
Courses and talks will be held at the second floor of LIT in the Auditorium Fernando Mendonça. The poster session will be held at the Atrium adjoining the Auditorium.



ground floor



1º floor



2º floor

1.5.1 Transportation

Getting in SJC departing from São Paulo

At Guarulhos Airport: Take the intercyte bus direclly to São José dos Campos. The service is operated by *Pássaro Marron* company. You can buy the ticket at www.passaromarron.com.br or at two booths located in terminal 2 or 4 of the airport. (cost R$ 18.5)

At Tiête Station: Take the intercity bus directly to São José dos Campos. The service is operated by *Pássaro Marron* company. You can buy the ticket at www.passaromarron.com.br or at the booth located in terminal 2. (cost R$ 24-28)

Getting in INPE

At the Intercyte Bus Terminal: Walk for about 750m to the bus stop at At the bus stop near Sonda Supermarket (at Av. Santos Dummont), take one of the lines in the table below. The bus fare is R$3.0 and it takes about 15 minutes with regular traffic . Alternatively, take a taxi (cost R$ 10.00).

At S.J.C. Airport: Take a taxi (INPE is 5 minutes from the airport).

At São José dos Campos, you can get in INPE by using one of the buses or van at list in the table below.

line code	name
Bus	
208	TERMINAL CENTRAL - JD. AEROPORTO (makes a longer path)
209	JD. UIRA - TERMINAL CENTRAL
212	PUTIM / TERMINAL CENTRAL – VIA AV. DOS ASTRONAUTAS
219	JD. SANTA LUZIA / TERMINAL CENTRAL
229	TERMINAL CENTRAL / JD. UIRA - VIA JOAO GUILHERMINO
334	SAO JUDAS TADEU / TERMINAL CENTRAL VIA TECNASA
360	VILA ADRIANA / TERMINAL CENTRAL – VIA AV. DOS ASTRONAUTAS
Van - Alternative	
20	COLORADO / OLIMPIO CATAO (CIRCULAR NO CENTRO)

bus stops

1.6 Meals

1.6.1 Restaurant for lunch

There will be an exclusive space for event attendees to lunch at a cost of R$ 18.00 per person including soft drinks / juice and dessert. Inside the INPE there is also a cafeteria where you can have lunch (buffet).

Option outside INPE but in its vicinity are the following:

- the Restaurant *Toca do Trairão* Av. Lívio Veneziani (Jd. Uirá), São José dos Campos - open for lunch.
- the snack bar *Veleiro do Açai* Rua Hidra 100 - open for dinner.

1.6.2 Coffe-Breaks

The coffee-break will be served at the Main Atrium (2).

1.7 Additional Information

1.7.1 Shopping Centers

- Centervale Shopping: www.centervale.com.br, Avenida Deputado Benedito Matarazzo, 9403 - Jardim Oswaldo Cruz São José dos Campos - SP (12) 3924-3000
- Vale Sul Shopping: www.valesulshopping.com.br, Av. Andrômeda, 227 - Jardim Satélite, São José dos Campos - SP, (12) 3321-0900
- Shopping Colinas: www.colinasshopping.com.br, Avenida São João, 2200 - Jardim das Colinas, São José dos Campos - SP, (12) 3924-4200

1.7.2 Banks and Currency Exchange

There are two banks offices inside of INPE: Banco do Brasil and Santander.
Currency Exchange: Confidence Câmbio at Shopping Colinas.

1.7.3 Pharmacy

Droga BELLA Rua Vesta, 43 - Jardim da Granja São José dos Campos - SP 12227-450

Annotations

Annotations