DY 59: Poster - networks

Time: Thursday 16:00–18:00 Location: Poster A

DY 59.1 Thu 16:00 Poster A

Topological Phenotypes in Complex Leaf Venation Networks — •Henrik Ronellenfitsch[1], Jana Lasser[1], Douglas Daly[2], and Eleni Katifori[1] — [1]Max Planck Institute for Dynamics and Self-Organization, Goettingen, Germany — [2]New York Botanical Garden, Bronx, NY, USA

The leaves of vascular plants contain highly complex venation networks consisting of recursively nested, hierarchically organized loops. We analyze the topology of the venation of leaves from ca. 200 species belonging to ca. 10 families, defining topological metrics that quantify the hierarchical nestedness of the network cycles. We find that most of the venation variability can be described by a two dimensional phenotypic space, where one dimension consists of a linear combination of geometrical metrics and the other dimension of topological, previously uncharacterized metrics. We show how this new topological dimension in the phenotypic space significantly improves identification of leaves from fragments, by calculating a "leaf fingerprint" from the topology and geometry of the higher order veins. Further, we present a simple model suggesting that the topological phenotypic traits can be explained by noise effects and variations in the timing of higher order vein developmental events. This work opens the path to (a) new quantitative identification techniques for leaves which go beyond simple geometric traits such as vein density and (b) topological quantification of other planar or almost planar networks such as arterial vaculature in the neocortex and lung tissue.

DY 59.2 Thu 16:00 Poster A

Complex Network Based Role Attribution in International and Intersectoral Trade — •Julian Maluck and Reik V. Donner — Potsdam Institute for Climate Impact Research, Germany

Supply chains in contemporary economy result in a complex network of trade relationships with a highly non-trivial topology. Multi-regional input-output tables summarize the monetary flows between industry sectors and can be meaningfully interpreted as a weighted and directed network of interacting subgraphs. We show that complex network theory provides sophisticated methods to attribute characteristic roles to industry sectors and countries. Specifically, in a directed network different patterns of clustering coefficients are attributed to different roles in the supply chain. In order to evaluate the robustness of trade relationships we introduce a generalization of the Hamming distance to weighted networks. In addition, we discuss how further standard network measures can be adapted on an economically meaningful way for studying the network properties of global trade.

DY 59.3 Thu 16:00 Poster A

Controllability of bipartite networks — •Chiranjit Mitra and Reik Donner — Potsdam Institute for Climate Impact Research, P.O. Box 60 12 03, 14412 Potsdam, Germany

We investigate the controllability of bipartite networks using the established concept of maximum matching as well as the more recently explored minimum dominating set approach. We consider random undirected bipartite networks consisting of two sets of N_1 and N_2 nodes, respectively, where every possible edge occurs independently with probability p. Under such settings, we find that for any given value of p, the number of unmatched nodes increases with $N_1 - N_2$. Likewise, for low values of p, although the domination number increases with $N_1 - N_2$ the change is not so sharp as compared to the change in the number of unmatched nodes obtained in a similar setting. However, for higher values of p, the domination number is almost independent of $N_1 - N_2$. For any given value of $N_1 - N_2$, the number of unmatched nodes is found to be mostly independent of p. On the other hand, for any given value of $N_1 - N_2$, the domination number decreases with increasing p. Moreover, we observe that at given values of $N_1 - N_2$ and p, the number of unmatched nodes is generally greater than or equal to the domination number.

DY 59.4 Thu 16:00 Poster A

Significance tests for topological characteristics of spatially embedded networks — •Marc Wiedermann[1,2], Jonathan F. Donges[1,3], Reik V. Donner[1], and Jürgen Kurths[1,2] — [1]Potsdam Insitute for Climate Impact Research, Germany — [2]Humboldt University, Berlin, Germany — [3]Stockholm Resilience Centre, Stockholm University, Sweden

Spatially embedded complex networks, i.e., networks where the nodes are embedded in some metric space, have attracted increasing attention in many fields of science. In such systems, it is of particular interest to study which network properties can solely be explained by the spatial embedding of the nodes and which are unique to the system under study with respect to a predefined null hypothesis. For this purpose, we introduce a set of random null models for spatially embedded networks, which are constrained by the spatial embedding of the nodes to different extents. These surrogate networks are generated by randomly shuffling edges in the original network but preserving spatial properties such as the edge length distribution or the average length of edges emerging from each node. For three different real world systems, we use our framework to evaluate to what extent measurable network characteristics can be explained by the spatial embedding of the system alone. The proposed random network models serve to generally evaluate the significance of links and network characteristics in general spatially embedded networks and are applicable also to functional networks, where links represent significant similarities between different localized areas or monitoring points in the system under study.

DY 59.5 Thu 16:00 Poster A

Symmetry-based coarse-graining of regular evolved networks — •Steffen Karalus and Joachim Krug — Institut für Theoretische Physik, Universität zu Köln

Virtually all empirical network structures are adjusted to their functional requirements by some evolutionary process adapting the topology for the specific needs. In most cases the functionality of a network is associated with the global behavior of dynamical processes based on the network. Many important processes are governed by the graph Laplacian. Its spectrum determines the overall behavior of such dynamics on a network. The strategy of evolutionary optimization can be successfully applied to find networks with a specific spectral dimension (power-law in the Laplacian spectrum) such that a non-trivial (subdiffusive) dynamical behavior emerges [1].

Networks evolved under the additional constraint of k-regularity exhibit an abundance of certain symmetric motifs. This can be exploited to construct quotient networks as systematic coarse-graining based on network symmetry [2]. This coarse-graining removes redundancies but retains the overall network structure. In this way we obtain a significant simplification of the evolved networks while the power-law spectrum and spectral dimension are preserved.

[1] S. Karalus and M. Porto, EPL 99, 38002 (2012).
[2] B. D. MacArthur and R. J. Sánchez-García, Phys. Rev. E 80, 026117 (2009).

DY 59.6 Thu 16:00 Poster A

Self-organized alternating chimera states in oscillatory media — •Sindre W. Haugland, Lennart Schmidt, and Katharina Krischer — Physik-Department, Nonequilibrium Chemical Physics, Technische Universität München, James-Franck-Str. 1, D-85748 Garching, Germany

Oscillatory media can exhibit the coexistence of synchronized and desynchronized regions, so-called chimera states, for uniform parameters and symmetrical coupling. In a phase-balanced chimera state, where the totals of synchronized and desynchronized regions, respectively, are of the same size, the symmetry of the system predicts that interchanging both phases still gives a solution to the underlying equations. Through simulations of an oscillatory medium governed by a complex Ginzburg-Landau equation with nonlinear global coupling, we observe this kind of interchange as a self-emergent phenomenon, occurring repeatedly for an apparently indefinite amount of time. Simulations also corroborate the hypothesis that a steady expansion of the turbulent phase is favoured, whereas a global constraint restricts its overall size. In contrast to the case of the non-alternating chimera states also found in our model system, the phase balanced state is not stable for alternating chimera states, leading to diffusional growth slightly beyond phase balance and a subsequent interchange of phases. The existence of self-emergent, self-sustaining alternating chimera states broadens the scope of future research into chimera states in general, and may help improve our understanding of chimera-like phenomena observed in biology.

DY 59.7 Thu 16:00 Poster A

Topological and geometrical properties of mitochondrial networks — •Andreas Veres, Sven Bauernfeind, and Matthias Weiss — University of Bayreuth, Bayreuth, Germany

Mitochondria typically form extended networks in eukaryotic cells which span throughout the cytoplasm. It is commonly believed that network formation correlates with the cells energy demand, yet the basic physico-chemical self-organization processes that govern network formation and maintenance are poorly understood. Using live-cell imaging and quantitative image analysis we have studied topological and geometrical properties of mitochondrial networks in untreated cells and in cells lacking microtubules. In particular, we have quantified the network efficiency via the "node betweenness" and we have used a number-and-brightness analysis and quantitative bleaching experiments to estimate the local flux within mitochondrial tubes. In response to drug treatment, we observed gross changes in the organization of mitochondria. Based on our experimental data, we have formulated a quantitative simulation model that rationalizes the observed transition.