DY 12 Statistical Physics of Complex Networks II

Time: Monday 11:00–13:00 Room: HÜL 186

DY 12.1 Mon 11:00 HÜL 186

Universal dependence of inter-node distances in complex networks — •Janusz A. Hołyst, Julian Sienkiewicz, Agata Fronczak, Piotr Fronczak, and Krzysztof Suchecki — Faculty of Physics, Warsaw University of Technology, Koszykowa 75, 00-662 Warszawa, Poland

We observe a universal scaling of internode distances in Erdős-Rényi random graphs, scale-free Barabási-Albert models, science collaboration networks, biological networks, Internet Autonomous Systems and public transport networks. The average shortest distance between two nodes of degrees k_i and k_j is equal to $\langle l_{ij} \rangle = A - B \log(k_i k_j)$. The scaling holds over several decades. We present a simple theory for the appearance of this scaling where parameters A and B depend on the mean value of a node degree $\langle k \rangle_{nn}$ calculated for the nearest neighbors and on network clustering coefficients. Corrections due to node degree-degree correlations are taken into account.

DY 12.2 Mon 11:15 HÜL 186

Scaling in canalyzing and other critical Kauffman networks — •Viktor Kaufman, Barbara Drossel, Tamara Mihaljev, and Ute Paul — Institute of Condensed Matter Physics, TU Darmstadt

The application of methods of statistical physics supported by numerical simulations leads to an intuitive and at the same time quantitative understanding of critical Kauffman Random Boolean networks(RBNs) with two inputs per node in the limit of large system size. We study standard RBNs as well as the special case of canalyzing RBNs, which were suggested to be suitable models for description of f.i. regulatory genetic networks. In the past few years unexpected results were found in such models. In particular we prove that canalyzing networks do not have substantially shorter or less attractors than other critical networks. Further similar models can be studied using our approach.

DY 12.3 Mon 11:30 HÜL 186

Monte Carlo sampling of cycles in large networks — •Konstantin Klemm and Peter F. Stadler — Dept. of Bioinformatics, Leipzig University

An important characteristic of many complex networks is redundant wiring, which leads to the occurrence of cycles. Abundance of small cycles, in particular triangles, has been widely studied. Larger cycles with lengths up to system size have received much less attention due to the lack of efficient numerical tools. Here we present a Markov chain Monte Carlo algorithm that is able to sample cycles of all lengths with equal probability. By choosing length dependent (Boltzmann) weights the equilibrium distribution can be tuned to particularly long or short cycles.

As the main result for growing networks, we find that the dependence between network size N and typical cycle length is algebraic [1], $\langle h \rangle \propto N^{\alpha}$, with distinct values of α for different wiring rules. The Barabasi-Albert model has $\alpha = 1$. Other preferential and non-preferential attachment rules and the growing Internet graph yield $\alpha < 1$.

[1] K. Klemm and P. F. Stadler, e-print cond-mat/0506493.

DY 12.4 Mon 11:45 HÜL 186

A Program Generating Homogeneous Random Graphs with Given Weights — •Leszek Bogacz[1], Zdzisław Burda[2], Wolfhard Janke[1], and Bartłomiej Wacław[2] — [1]Institut für Theoretische Physik, Universität Leipzig, Augustusplatz 10/11, 04109 Leipzig, Germany — [2]Institute of Physics, Jagellonian University, Reymonta 4, 30-059 Krakow, Poland

We present a program package [1] which generates homogeneous random graphs with probabilities prescribed by the user. The statistical weight of a labeled graph α is given in the form $W(\alpha) = \prod_{i=1}^{N} p(q_i)$, where $p(q)$ is an arbitrary user function and q_i are the degrees of the graph nodes. The program can be used to generate two types of graphs (simple graphs and pseudo-graphs) from three types of ensembles (microcanonical, canonical and grand-canonical).

Its functionality will be explained in the talk with a few simple but characteristic examples.

[1] L. Bogacz, Z. Burda, W. Janke, and B. Wacław, cond-mat/0506330, to appear in Comp. Phys. Comm. (in print).

DY 12.5 Mon 12:00 HÜL 186

Coupled Multiplicative Stochastic Processes on Networks — •Stefano Battiston — Chair of Systems Design, ETH Zurich, CH-8092 Zurich, Switzerland

We consider a system of coupled multiplicative stochastic process (MSP) with repulsive barrier, taking place on a network. We investigate by means of computer simulations the stationary distribution and the spatial correlations of such a system. While it is well know that a MPS with repulsive barrier produces a power law distribution, less attention has been drawn so far on the fact that even a weak local coupling destroys the power law and produces much less heterogeneous distributions. This fact raises an apparent contradiction because, several systems that can be described as strongly coupled MSP on a network, including some models of production networks, yet display power law distributions. A simple solution to such inconsistency is represented by asymmetric coupling. In this work we show that asymmetry allows both for strong coupling and power laws.

DY 12.6 Mon 12:15 HÜL 186

Statistical analysis of Polish public transport networks. — •Julian Sienkiewicz and Janusz A. Hołyst — Faculty of Physics, Warsaw University of Technology, Koszykowa 75, 00-662 Warszawa, Poland

We have analyzed Polsih public transport networks of sizes ranging form $N = 152$ to $N = 2881$. Depending on the assumed definition of network topology the degree distribution can either follow a power law or can be described using an exponential function. Distributions of path lengths in all considered networks are given by asymmetric, unimodal functions. Clustering, assortativity coefficient and betweenness centrality are studied. All considered networks exhibit small world behavior and are hierarchically organized. We have observed a transition between dissortative small networks $N < 500$ and assortative large networks $N > 500$.

Invited Talk

DY 12.7 Mon 12:30 HÜL 186

The scaling laws of human travel — •Dirk Brockmann[1], Lars Hufnagel[2], and Theo Geisel[1] — [1]MPIDS, Göttingen — [2]KITP, UCSB, Santa Barbara, USA

In the light of increasing international trade, intensified human mobility and an imminent influenza A epidemic the knowledge of dynamical and statistical properties of human travel is of fundamental importance. Despite its crucial role, a quantitative assessment of these properties on geographical scales remains elusive and the assumption that humans disperse diffusively still prevails in models. I will report on a solid and quantitative assessment of human travelling statistics by analysing the circulation of bank notes in the United States. Based on a comprehensive dataset of over a million individual displacements we find that dispersal is anomalous in two ways. First, the distribution of travelling distances decays as a power law, indicating that trajectories of bank notes are reminiscent of scale free random walks known as Lévy flights. Secondly, the probability of remaining in a small, spatially confined region for a time T is dominated by algebraic tails which attenuate the superdiffusive spread. We show that human travel can be described mathematically on many spatiotemporal scales by a two parameter continuous time random walk model to a surprising accuracy and conclude that human travel on geographical scales is an ambivalent effectively superdiffusive process.

[1] Brockmann, D., L. Hufnagel, and T. Geisel, The scaling laws of human travel. Nature, 2006 (to be published).

[2] Hufnagel, L., D. Brockmann, and T. Geisel, Forecast and control of epidemics in a globalized world. PNAS, 2004. 101(42): p. 15124-15129.