SOE 20: Nonlinear Dynamics 2: Stochastic and Complex Systems, Networks (joint session DY/SOE)

Time: Friday 11:30–12:45 Location: H19

SOE 20.1 Fri 11:30 H19

Thermodynamic uncertainty relations for many-body systems with fast jump rates and large occupancies — •Ohad Shpielberg[1] and Arnab Pal[2] — [1]University of Haifa, Haifa, Israel. — [2]Department of Physics, Indian Institute of Technology, Kanpur, India

The thermodynamic uncertainty relations constitute an important inequality, bounding the entropy production through current fluctuations. The results have been successfully applied, in particular for single body dynamics. Here we present uncertainty relations and other useful inequalities for the many body systems, in the limit of highly occupied systems. The resulting coarse grained theory also accounts for tighter inequalities than the single body case.

SOE 20.2 Fri 11:45 H19

Effects of measures on phase transitions in two cooperative susceptible-infectious-recovered dynamics — Adib Khazaee[1] and •Fakhteh Ghanbarnejad[1,2] — [1]Sharif University of Technology, Tehran, Iran — [2]Chair for Network Dynamics, Institute for Theoretical Physics and Center for Advancing Electronics Dresden (cfaed),Technical University of Dresden, 01062 Dresden, Germany

In recent studies, it has been shown that a cooperative interaction in a co-infection spread can lead to a discontinuous transition at a decreased threshold. Here, we investigate effects of immunization with a rate proportional to the extent of the infection on phase transitions of a cooperative co-infection. We use the mean-field approximation to illustrate how measures that remove a portion of the susceptible compartment, like vaccination, with high enough rates can change discontinuous transitions in two coupled susceptible-infectious-recovered dynamics into continuous ones while increasing the threshold of transitions. First, we introduce vaccination with a fixed rate into a symmetric spread of two diseases and investigate the numerical results. Second, we set the rate of measures proportional to the size of the infectious compartment and scrutinize the dynamics. We solve the equations numerically and analytically and probe the transitions for a wide range of parameters. We also determine transition points from the analytical solutions. Third, we adopt a heterogeneous mean-field approach to include heterogeneity and asymmetry in the dynamics and see if the results corresponding to homogeneous symmetric case stand. (Physical Review E 105 (3), 034311)

SOE 20.3 Fri 12:00 H19

ANDOR and beyond: Dynamically switchable logic gates as modules for flexible information processing in biochemical regulatory networks — •Mohammadreza Bahadorian[1,2] and Carl D. Modes[1,2,3] — [1]Max Planck Institut for Molecular Cell Biology and Genetics (MPI-CBG), 01307 Dresden, Germany — [2]Center for Systems Biology Dresden (CSBD), 01307 Dresden, Germany — [3]Cluster of Excellence Physics of Life, TU Dresden, 01069 Dresden, Germany

Understanding how complex (bio-)chemical regulatory networks may be capable of processing information in flexible, yet robust ways is a key question with implications in biology and dynamical systems theory. Considerable effort has been focused on identification and characterization of structural and dynamical motifs of biological information processing, but a framework for studying flexibility and robustness of the motifs is lacking. We here propose a small set of effective modules capable of performing different logical operations based on the basin of attraction in which the system resides. These dynamically switchable logic gates require fewer components than their traditional analogs where static, separate gates are used for each desired function. We demonstrate the applicability and limits of these circuits by determining a robust range of parameters over which they correctly operate and then characterize their resilience against intrinsic noise of the constituent reactions using the theory of large deviations. Trade-offs between multi-functionality and robustness against various types of noise are shown.

SOE 20.4 Fri 12:15 H19

Memory formation in adaptive networks — •Komal Bhattacharyya[1], David Zwicker[1], and Karen Alim[1,2] — [1]Max Planck Institute for Dynamics and Self-Organization, 37077 Göttingen, Germany — [2]Physik-Department, Technische Universität München, Garching, Germany

Continuous adaptation of networks like our vasculature ensures optimal network performance when challenged with changing loads. Here, we show that adaptation dynamics allow a network to memorize the position of an applied load within its network morphology. We identify that the irreversible dynamics of vanishing network links encode memory. Our analytical theory successfully predicts the role of all system parameters during memory formation, including parameter values which which prvent memory formation. We thus provide an analytically tractable theory of memory formation in disordered systems.

SOE 20.5 Fri 12:30 H19

Inference of fractional nonlinear models from temperature time series and application to predictions — •Johannes A. Kassel and Holger Kantz — MPI for the Physics of Complex Systems, Dresden, Germany

We introduce a method to reconstruct macroscopic models of one-dimensional nonlinear stochastic processes with long-range correlations from sparsely sampled time series by combining fractional calculus and discrete-time Langevin equations. We reconstruct a model for daily mean temperature data recorded at Potsdam (Germany) and use it to predict the first frost date. Including the Arctic Oscillation Index as an external driver into our model, we predict extreme temperatures for several European weather stations, illustrating the potential of long-memory models for predictions in the subseasonal-to-seasonal range.

[1] Johannes A. Kassel and Holger Kantz, Phys. Rev. Research 4, 013206