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CP25

Exploring the Hyperbolicity of Chaotic Rayleigh-Bénard Convection

Covariant Lyapunov vectors allows us to quantify the direction of the stable and unstable manifolds of the tangent space for the high-dimensional chaotic dynamics of Rayleigh-Bénard convection. The principal angle between these manifolds can be used to determine the hyperbolicity of the dynamics. We use numerical simulations to compute the covariant Lyapunov vectors of Rayleigh-Bénard convection to probe fundamental features of the dynamics of an experimentally accessible and high-dimensional system.

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CP25

Snakes on An Invariant Plane: Coupled Translational-Rotational Dynamics of Flying Snakes

Flying snakes of the genus *Chrysopelea* use body flattening and three-dimensional body undulations in a dynamic yet controlled glide through air. Given this complexity, salient body dynamics relevant to glide stability are unknown. We investigate a tandem airfoil model with snake-like features to better understand aerodynamic effects of undulation and translational-rotational mechanical coupling on motion and stability during a glide. We elucidate some dynamical phenomena that occur including bifurcations, limit cycles, and a gliding manifold.

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CP26

Constant Rebalanced Portfolio Strategy Is Rational in a Multi-Group Asset Trading Model

We evaluate the performance of various trading strategies within the context of the multi-group asset flow differential equations model. We consider scenarios in which strategies vary continuously and slowly, and derive mathematical justification for constant rebalanced portfolio (CRP) strategies. The CRP strategy minimizes investment risks as investor wealth is maintained when the price moves from and then returns to its original value; non-CRP strategies may be exploited by others resulting in a loss of wealth.

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CP26

How Monetary Policy Can Cause Forecasting Uncertainty

Federal Reserve Chairwoman Yellen seems to be guided by a rule that keeps interest rates low (high), when the economy is operating below (above) its trend. Instead of stabilizing the economy, the unintended consequence of the Yellen Rule is greater uncertainty, due to nonlinear feedback. The resulting forecast errors can be modeled by applying a Sprott nonlinear dynamical system of simple chaos, perturbed by random noise and shocked by excess demand for real money.

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CP26

Non-Smooth Dynamics and Bifurcations in a Model of Electricity Market

This paper proposes a model for the supply and demand of electricity in a domestic market based on system dynamics. Additionally, the model shows piecewise-smooth differential equations. Mathematical analysis and simulation explain some counter-intuitive dynamics which also were detected in practice. Then, a general model is proposed, which is closer to real electricity markets. Discontinuities have a large effect on the qualitative analysis. A first result to be noted is the use of asynchronous maps for understanding what happens when parameters are varied, leading to non-smooth bifurcations. To our knowledge. there are still no reports in the literature about its use in socio-economic market systems. The other noteworthy result in this research is the effect that the *ROI* (Investment returns) has on the system dynamics since it leads to different surfaces whose slope change according to the parameters.

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CP27

Towards Understanding Mechanisms of Pain Transmission: a Systems Theoretic Approach

Pain is a universal experience. Motivated by a lack of understanding of pain mechanisms, we develop a reduced low-dimensional model of the dorsal horn circuit—the first central relay of sensory inputs to the brain. We determine how a cellular switch of firing patterns in dorsal horn transmission cells—tonic, plateau, endogenous bursting—contributes to a functional switch of information transfer—faithful transmission, enhancement, or blocking of nociceptive information.

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Optogenetic Stimulation of a Meso-Scale Human Cortical Model

Mesoscale models of cortical activity provide a means to study neural dynamics at the level of neuron populations, and offer a safe and economical way to test the effects and efficacy of stimulation techniques on the dynamics of the cortex. Here, we use a physiologically relevant mesoscale model of the cortex, consisting of a set of stochastic, highly non-linear partial differential equations, to study the hypersynchronous activity of neuron populations during epileptic seizures. We use optogenetic stimulation to control seizures in a hyperexcited cortex, and to induce seizures in a normally functioning cortex. The high spatial and temporal resolution this method offers makes a strong case for the use of optogenetics in treating epileptic seizures. We use bifurcation analysis to investigate the effect of optogenetic stimulation in the meso scale model, and its efficacy in suppressing the non-linear dynamics of seizures.

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CP27

Assessing the Strength of Directed Influences Among Neural Signals

Inferring Granger-causal interactions between processes promises deeper insights into mechanisms underlying network phenomena, e.g. in the neurosciences where the level of connectivity in neural networks is of particular interest. Renormalized partial directed coherence can be used to investigate Granger causality in such multivariate systems. A major challenge in estimating respective coherences is a reliable parameter estimation of vector autoregressive processes. We discuss improvements of the estimation procedure that are particularly relevant in the neurosciences.

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CP27

Analysis of Cholera Epidemics with Bacterial Growth and Spatial Movement

In this work, we propose novel epidemic models for cholera dynamics by incorporating a general formulation of bacteria growth and spatial variation. In the first part, a generalized ODE model is presented and it is found that bacterial growth contributes to the increase of the basic reproduction number. With the derived basic reproduction number, we analyze the local and global dynamics of the model. Particularly, we give a rigorous proof on the endemic global stability by employing the geometric approach. In the second part, we extend the ODE model to a PDE model with the inclusion of diffusion to capture the movement of human hosts and bacteria in a heterogeneous environment. The disease threshold of this PDE model is studied again by using the basic reproduction number. The results on the threshold dynamics of the ODE and PDE models are compared, and verified through numerical simulation.

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CP27

Benefits of Noise in Synaptic Vesicle Release

Noise is not only a source of disturbance but can also be beneficial for neuronal information processing. The release of neurotransmitter vesicles in synapses is an unreliable process, especially in the central nervous system. Here we study the effect of the probabilistic nature of this process and show that how stochasticity in vesicle docking and release can be beneficial for synaptic transmission.

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CP27

Growth Dynamics for Pomacea Maculata

Pomacea maculata is a relatively new invasive species to the Gulf Coast region and potentially threatens local agriculture (rice) and ecosystems (aquatic vegetation). The population dynamics of *Pomacea maculata* have largely been un-quantified. We directly measured the growth rates of individually marked snails grown in a common tank to quantify their growth patterns. However, due to large intra- and inter- individual variability and sample size, we were not able to get statistically rigorous estimates (i.e., tight confidence intervals) on overall growth dynamics. However, we were able to use a model comparison statistic to determine that there are distinct growth stages. Further, these data