Contributed Session 10: Bifurcation and chaotic dynamics

Chaotic behavior in a hybrid dynamical system that arises from electronics

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We report on some numerical investigations on the chaotic behavior of a hybrid dynamical system that arises in electronics. We have used the softwares MatLab-Simulink-Stateflow and Scilab-Scicos.

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Bifurcation Analysis of Predator-Prey Systems with Constant Rate Harvesting Using Non-Standard Discretization

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We formulate and apply non-standard discretization methods that enable us to study the saddle, elliptic and parabolic cases of the predator-prey system with constant rate harvesting as difference dynamical systems. Our models have the same qualitative features as their corresponding continuous models. By choosing appropriate bifurcation parameters, we combine analytical and numerical investigations to produce interesting global bifurcation diagrams, including saddle-node, Hopf and Bogdanov-Takens bifurcations.

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When the stock market bubbles like a chaotic rossler system

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To ensure the stability of a complex learning economy there must be an appropriate target for the short-term interest rate. Then everyone can learn to more quickly correct their economic forecast and coordination errors. The Federal Reserve System was created in part to provide this guidance. However, its policy is now destabilizing the stock market and ultimately the whole economy. The Fed's current interest rate target over-reacts to changes in inflation and output, causing chaotic turning points in the economy. This is a consequence of how monetary policy makes the interaction of excess stock returns, inflation, and interest rates behave like a transient Rossler system, the simplest way to model chaos in continuous time. But there is a better way to effectively guide everyone's search for rationality by pegging the short-term, nominal interest rate to eventually equal its real expectation. This occurs as long as the trend money supply is targeted to grow at a non-inflationary rate. Then convergence to a rational expectations equilibrium speeds up in a dynamic Keynesian model of a closed economy.

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An other strange attractor from chen system

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From direct modification of the Chen equation, one can obtain a new continuous-time three dimensional autonomous chaotic system. We study the dynamical behavior of this system. Equilibrium points and their stability are discussed. Basic dynamical behaviours are briefly described. The possibility of circuitry realization is presented. The existence of chaotic attractors is justified with various numerical results which give some new chaotic solutions. Keywords: Chen equation; 3-D autonomous system; Chaos.

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On chaotic dynamics in discrete homogeneous quadratic systems

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The theory of Julia sets originates from considering the dynamics of the complex squaring map. The complex squaring map is analytic, but there are many other homogenous quadratic maps in the plain which are not analytic. Actually, the analyticity is rather an exception. It is well known that homogenous quadratic maps are in one to one correspondence with two dimensional commutative algebras (c.f. [2]). In this talk we will consider the

dynamics on the generalization of the Julia set which is obtained from a quadratic map $(x,y) \to (x^2 - y^2, xy)$ associated to the algebra with the most similar properties to the algebra of complex numbers. The considered map is not analytic but I will show (c.f. [1]) that the dynamics on the generalized Julia set is similar to J_0 for the complex squaring $(x,y) \to (x^2 - y^2, 2xy)$. Finally, I will comment the expected behavior in other systems which correspond to the same class of algebras as the complex squaring and the map $(x,y) \to (x^2 - y^2, xy)$ (i.e. the commutative two-dimensional algebras with one idempotent and no nilpotents of rank two).

References:
[1] M. Kutnjak, On Chaotic Dynamics of Nonanalytic Quadratic Planar Maps, to appear in Nonlinear Phenom. Complex Syst.
[2] L. Markus, Quadratic Differential Equations and Nonassociative Algebras, Ann. Math. Studies. **45**, no. 3 185-213 (1960).

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Bifurcation Basins in Noninvertible Maps with Denominator

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The dynamics of noninvertible maps with denominator is studied. We present examples of some bifurcations in systems derived from several families of polynomial factorization methods applied to low-order polynomials. We study the interactions of fixed points, singular curves, and invariant lines, we present some possible interesting bifurcations and eruptions. We define an eruption as a bifurcation involving the merger of an attracting periodic orbit or fixed point with a point on a singular curve. This results in a transfer of stability from the attracting periodic orbit to another invariant set. The main focus of this work is the characterization of some bifurcations found in families of noninvertible maps and the role played by singularities in their global dynamics.

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Master-Slave Synchronization of Lorenz Systems via Single Controller

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Synchronization of nonlinear systems is a challenging task for several points of view. One of them is to understand why the synchronization occurs in different branches of physics, chemistry and biology. Another one is to design the coupling in order to obtain synchronization. This can be done by (i) using a variable of the driver (master) in the receiver (slave) or by (ii) using a suitable feedback coupling between driver (master) and the receiver (slave). After the paper by Pecora and Carroll many results have been reported, mainly by proposing a feasible simple coupling term. Another general method is based on the Open-Plus-Closed-Loop (OPCL) strategy. In this work a single controller for synchronization of two Lorenz systems is obtained by using a Liapunov function. Numerical results are given for the all three cases with one controller in each other equation. This type of synchronization is superior to the OPCL synchronization for three reasons: (i) it has one controller (it means the coupling is in one equation of the slave system) (ii) the synchronization is obtained from any initial condition (iii) changing the parameter, the rate of synchronization can be modified (if the derivative dL/dt, where L is the Liapunov function, has a smaller negative value then the synchronization will be faster). The coupling term can contain 2 or 3 variables of the master system.

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Chaotic behaviour of differential operators on Hilbert spaces of entire functions

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An operator $T : X \to X$ on a Banach space X is chaotic in the sense of Auslander and Yorke if it presents sensitive dependence on initial conditions and it is hypercyclic (i.e., there are $x \in X$ whose orbit $Orb(T,x) := \{x, Tx, T^2x, \dots\}$ is dense in X). Within our framework, hypercyclicity implies Auslander-Yorke chaos. Chan and Shapiro [ChSh] considered the Hilbert spaces $E^2(\gamma)$ of entire functions with restricted growth. They proved that the translation operator $f(z) \mapsto (T_a f)(z) = f(z+a)$ is hypercyclic on $E^2(\gamma)$, and they asked about hypercyclicity of other differential operators defined on $E^2(\gamma)$. We characterize the hypercyclic differential operators on $E^2(\gamma)$.

[ChSh] K. Chan and J.H. Shapiro, The cyclic behavior of translation operators on Hilbert spaces of entire functions, Indiana Univ. Math. J. **40** (1991), 1421??1449.

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Julia sets of two permutable entire functions

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We show that for a certain class of entire functions f, any other entire function g that permutes with f,i.e., f(g)=g(f), then f and g have the same Julia set.In the proof, Nevanlinna's value distribution theory will be used.

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Attractors of ecosystems compartment dynamic models: qualitative behavior of open local and closed global matter cycles

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Dynamic properties of open and closed compartment ecosystem models where some flow functions are saturated and the rest are selected as linear or of Lotka-Volterra type are investigated. Stability and bifurcations of equilibria and existence of regular and chaotic oscillatory regimes as the typical problem in dynamic system theory are the main subjects of attention. The global carbon cycle four-dimensional compartment schemes built by an aggregated data from a number of high-dimensional diagrams initiate an example of a closed dynamic model and its modifications from a considered class. For studying the functioning of the global carbon cycle an existence, stability and bifurcations of equilibria and periodic solutions are considered using the total amount of carbon and the rate of anthropogenic input to the atmosphere as bifurcation parameters. Embedding of equation for the simplest climatic factor ??? the globally averaged annual temperature of the surface - and linking it with main intercompartment flows modify the model and allow one to obtain climate-induced boundaries of stability domains for possible equilibria of global carbon cycle. Temperature variation in accordance with different climatic scenarios as well as human perturbations trend initiates the transition scheme from one stable attractor to another thus simulating probable tendencies in functioning of coupled climatic and biotic machines on the Earth. Oscillatory regimes, regular and chaotic, as well as a mechanism leading to the strange attractor formation, for the open model of organic matter cycling in a bog ecosystem confirm complexity and nonlinearity of ecosystem functioning.

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