Workshop on Dynamical Systems and Applications

Departamento de Matemática Aplicada

May 8th, 2012
Place

Room 2.32.
Department of Applied Mathematics, ETSI Industriales (UNED).

Organizing and Scientific Committee:

Ignacio Bajo (U. Vigo);
Daniel Franco (UNED) chair;
Eduardo Liz (U. Vigo);
Juan Perán (UNED).

Timetable

<table>
<thead>
<tr>
<th>Time</th>
<th>Speaker/Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>09:45 - 10:00</td>
<td>Reception</td>
</tr>
<tr>
<td>10:00 - 10:45</td>
<td>Miguel A. F. Sanjuán (University Rey Juan Carlos, Spain)</td>
</tr>
<tr>
<td>10:45 - 11:30</td>
<td>Eduardo Liz (University of Vigo, Spain)</td>
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<tr>
<td>11:30 - 12:00</td>
<td>Coffee break</td>
</tr>
<tr>
<td>12:00 - 12:45</td>
<td>Frank Hilker (University of Bath, UK)</td>
</tr>
<tr>
<td>12:45 - 13:30</td>
<td>Liang Huang (Lanzhou University, China)</td>
</tr>
<tr>
<td>13:30 - 15:30</td>
<td>Lunch</td>
</tr>
<tr>
<td>15:30 - 16:00</td>
<td>Juan Sabuco (University Rey Juan Carlos, Spain)</td>
</tr>
<tr>
<td>16:00 - 16:30</td>
<td>Pablo Carmona (UNED, Spain)</td>
</tr>
<tr>
<td>16:30 - 17:00</td>
<td>Alfonso Ruiz-Herrera (University of Granada, Spain)</td>
</tr>
<tr>
<td>17:00 - 17:30</td>
<td>Sijo K. Joseph (University Rey Juan Carlos, Spain)</td>
</tr>
</tbody>
</table>
PARTIAL CONTROL OF CHAOTIC SYSTEMS: AN OVERVIEW

Miguel A. F. Sanjuán (Univ. Rey Juan Carlos, Spain)

Abstract.- The aim of the Partial Control [1,2] is to avoid escapes of some region of the phase space, in a nonlinear system in which some noise has also been added. Typically in this kind of systems we need a control higher or equal to the amount of noise added, using other control techniques, but using the partial control technique it is possible to avoid the escapes even if the control is smaller than the noise. In this talk I will report about further progress in this controlling chaos technique. In particular I will describe the Sculpting Algorithm which we have developed in order to build safe sets, which are sets in phase space where using a control smaller than noise makes it possible the chaotic dynamical system to be controllable. We have found another set, that we call asymptotic safe set, where trajectories go after the partial control strategy is applied. All these ideas are applied to two paradigmatic examples, the Hénon map and a Duffing oscillator showing the geometry of these sets in phase space. This is joint work with James A. Yorke (USA), Samuel Zambrano (Italy) and Juan Sabuco (Spain).

References.

STABILIZATION OF PERIODIC POINTS WITH AND WITHOUT PULSES

Eduardo Liz (Univ. Vigo, Spain)

Abstract.- In this talk we present some results about stabilization of fixed points and periodic orbits of one-dimensional discrete dynamical systems; in some cases, we prove that the stabilized orbit is globally attracting. We also consider the case when control intervention does not occur at every iteration. This aspect is very important in practical situations because sometimes it is either not feasible or very costly to apply the control at each step. We show that there are some situations where a pulse control strategy provides even better results than the corresponding method without pulses.

We explore three different control techniques: proportional feedback control (PFC), delayed feedback control (DFC), and prediction-based control (PBC). Both DFC and PBC are designed to stabilize a periodic orbit of the original system.
CHAOTIC ATTRACTORS AND THEIR CRISES IN ECO-EPIDEMIOLOGICAL MODELS

Frank Hilker (Univ. Bath, United Kingdom)

Abstract. We will consider eco-epidemiological models that integrate infectious disease dynamics into populations of prey and predators. These models allow us to study the impact of pathogens on food web stability on the one hand and how ecological community composition affects disease emergence on the other hand.

The resulting dynamics can be surprisingly complex, including non-equilibrium coexistence on cyclic and chaotic attractors, multistability and boundary as well as interior crises of chaotic attractors.

The results highlight the role of parasites in food webs that have often been neglected. Using a fruitful cross-fertilisation, we also find similar results in purely ecological communities and thus contribute to a unifying theory. We will discuss our findings with a special emphasis on potential control measures in terms of bioconservation, disease eradication and pest control.

(This is joint work with Michael Sieber, U. Exeter.)

SYNCHRONIZABILITY OF COUPLED DYNAMICAL SYSTEMS WITH ONE-COMPONENT COUPLINGS

Liang Huang (Lanzhou University, China)

Abstract. Master stability method decouples the synchronization of coupled dynamical systems into two constituents: the master stability function of a single dynamical system and the couplings between them. The method is so powerful that shortly after it is proposed, the research focus of the field has drifted to the pure couplings, i.e., the different network structures that describe how the nodes (resides a dynamical system) are connected to each other, and take the required properties (two cross points) of the dynamical system for granted. We revisited the commonly used dynamical systems and investigated their master stability functions, and confirmed that although the property does not hold in general, most systems have certain special couplings that do have two cross points, landing the investigations on a solid ground. The talk will discuss both continuous and discrete dynamical systems.
HOW TO COMPUTE SAFE SETS IN PARTIAL CONTROL OF CHAOS

Juan Sabuco. (Univ. Rey Juan Carlos, Spain)

Abstract.- Safe sets are a basic ingredient in the strategy of partial control of chaotic systems. Recently we have found an algorithm, the Sculpting Algorithm, which allows us to construct them, when they exist. We define here another type of set, an asymptotic safe set, where trajectories wander after the partial control strategy has been applied. We apply all these ideas to an specific example of a Duffing oscillator showing the geometry of these sets in phase space. This is joint work with James A. Yorke (USA), Samuel Zambrano (Italy) and Miguel A.F. Sanjuán (Spain).

References.


NONLINEAR FEEDBACK METHOD FOR CHAOS CONTROL

Pablo Carmona (UNED, Spain)

Abstract.- In this talk we will put forward a new strategy to control the dynamics of one dimensional discrete dynamical systems. We will point out some advantages and disadvantages of the proposed method in comparison to others, as proportional feedback control or target-oriented control. As we will see, the main difference with other proposed strategies in the literature is the nonlinear behaviour of the control. We will illustrate our results and conjectures using the classical Ricker model. This is a joint work with Daniel Franco (UNED).

CHAOS IN DISCRETE STRUCTURED POPULATION MODELS

Alfonso Ruiz-Herrera (Univ. Granada, Spain)

Abstract.- We prove analytically the existence of chaotic dynamics in some classical discrete-time age-structured population models. Our approach allows us to estimate the sensitive dependence on the initial conditions, regions of initial data with chaotic behavior, and explicit ranges of parameters where the considered models display chaos. These properties have important implications to evaluate the influence of a chaotic regime in the predictions based
PHASE CONTROL OF CHAOTIC MAPS

Sijo K. Joseph (Univ. Rey Juan Carlos, Spain)

Abstract.- Controlling chaos represents one of the most interesting and challenging problems in the field of nonlinear dynamics. There are two different kinds of control methods, feedback and nonfeedback methods. Important classes of nonfeedback method are based on applying a small harmonic perturbation with a suitable phase either to some of the parameters of the system or as an additional driving. This phase plays an important role and it can be adjusted in order to select different behaviors of the dynamical system. This technique is known as phase control and it has been mainly used to suppress chaos in periodically driven dynamical systems [1-2]. The main goal of this work is to apply a control technique, typically applied to continuous dynamical systems, the phase control technique, to control the dynamics of the bouncing ball system. Bouncing ball system is a simple dynamical system in which a ball bounces on a vertically oscillating table [3]. This system is very attractive because of its rich dynamical behavior. It presents a period doubling route to chaos when some control parameter is varied. In particular, we are considering a map that represents the bouncing ball system with a high bounce approximation. The key idea of this work is to analyze the dynamical behavior of the model by means of an adequate selection of the phase of the applied small harmonic perturbation, that is acting on one of the parameters of the dynamical equations. We show that the phase control method is useful in suppressing or generating chaotic behavior and in modifying the period of a periodic orbit. The phase enhances the size of the attractor near a crisis and can induce the intermittent behavior, this intermittency also shows a scaling behavior. This is a joint work with Inés P. Maríño and Miguel A. F. Sanjuán.

References.